POWER

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A Happy New Year

THE old year, with all its achievements and failures, its satisfactions and disappointments, its joys and its griefs, is behind us.

Its 525,600 minutes have been spent. What have we bought with them? What have we to show for it?

The new year lies before us, a clean unwritten page, replete with possibilities. What shall the story be which it will carry into history when, a year from now, it is turned over — into the world's history; into our life's story, yours and mine?

The real fellow is, of course, he who plays the game the best that he knows how all the time. If he has a bad inning or a bad hole, he braces up and goes after the next with all the more concentration and purpose, and refuses to be set back by misfortune or subdued into mediocrity by temporary lack of success.

Most of us, however, get to plodding even if we do not stumble; and we welcome a pause, a turning point in the game, a chance to size up the score and take a new hold on life. And we do this at New Years. This Monday is not different from a lot of other Mondays; this week will not be different from a lot of other weeks, but we are starting in with a clean slate and a new resolve to make the most of the year that is before us and so to live that as memory turns its page it will find transcribed thereon the most of satisfying accomplishment and the least of sorrow and regret.

And for each and all I hope that the coming year may be replete with happiness and success.

F. R. Low

A Year of Progress in the Power-Plant Field

Advances in Steam Pressure, Intense Interest in Powdered Coal, Unusual Activity in the Construction of Large Plants and All Previous Records Broken in the Size of Steam Turbines, Hydro-Electric Units, Transformers and Switching Equipment Are Some of the Outstanding Features of 1922

OVER conditions of a year ago the general business situation "is so improved as to be incomparable." The authority for the quotation is Herbert Hoover, and evidence is not lacking to back such a statement. Statistics issued by the National Industrial Conference Board show an increase in industrial activity of 22.6 per cent over 1921. During the last few months the gain has been consistent and rapid, and although some of the improvement may be attributed to seasonal influences, the larger part is credited to fundamental business recovery, with every indication that the movement is to be definitely upward. From practically every state in the Union reports show sound conditions in the basic industries. Recovery from the difficulties imposed by the labor troubles in the railway and coal-mining fields has been rapid and increase in employment is general.

Outlook in the Power Industry Promising

ACCOMPANYING this activity is a marked increase in the demand for industrial power. Late reports of the United States Geological Survey, compiled from actual returns of central-station companies, show that the demand curve has been rising steadily and is pointing sharply upward. For the first nine months of the year the output was 15 per cent above that for a like period in 1921 and 30 per cent over that for 1919. This increase in the demand, coupled with a lack of construction during and immediately after the war, is the cause of the remarkable expansion. A great number of new central stations and additions to existing plants are under way. Approximately 1,200,000 kw. in large turbo-generators are being installed or are on order, and this is exclusive of ultimate capacities for which contracts have not been let.

Reliable estimates made during the year placed the investment in equipment to meet the increasing demand for electrical energy at $324,000,000. This record figure for extensions to generating and distributing systems, is in excess of the total income of the industry in 1913 and 51 per cent more than similar expenditures in 1921.

Of the 21,000,000 hp. involved in applications before the Federal Power Commission for hydro-electric plants, over 2,000,000 hp. has been approved and represents developments under construction or about to be started. Preliminary permits now outstanding represent nearly 2,500,000 hp. additional. From the latest Census returns, now two years old, the growth in primary power in industrial plants for the ten-year period preceding the compilation, has been at the rate of over a million horsepower per year, and this is exclusive of power plants in office buildings, hotels, etc.

Considering central stations and private plants for all services, conservative estimates place immediate expenditures close to a billion dollars. This is for primary power alone and does not include transmission, the application of this power and the supplies and renewable equipment involved.

Higher Steam Pressures Have Been Adopted Commercially

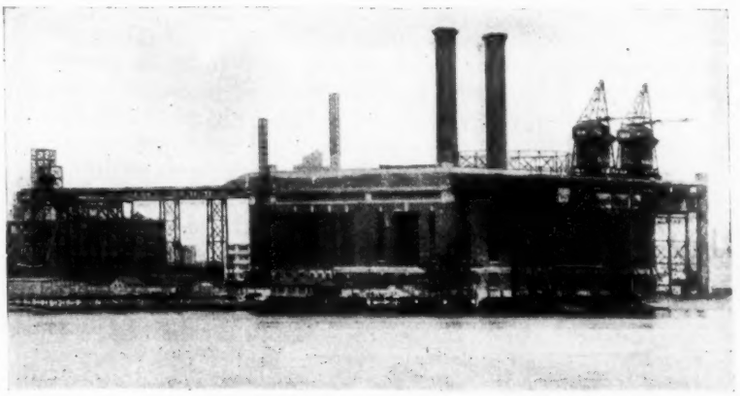
ALTHOUGH there have been few fundamental developments in the power-plant field during the year, there has been considerable advance along certain definite lines. Perhaps the most noticeable movement has been a continuation in the advance toward higher pressures. During recent years there has been a general upward trend in pressures to the extent that there are now operating in this country six large stations at steam pressures from 275 to 300 lb. per sq.in. and eight at pressures between 300 and 350 lb. per sq.in. Eleven of these plants are operating at steam temperatures ranging between 640 and 700 deg. F. In the industrial field pressures of 250 to 275 lb. are becoming standard.

For a period the troubles encountered with fittings and those resulting from misalignment and unprovided-for expansion in the early stations using high temperatures, checked the advance. That these difficulties have been overcome to a great extent is evident from announcements during the later months of the year of several large stations in which steam pressures will exceed the foregoing limits. In these installations higher pressures are the rule, the superheat being limited, so that final temperatures do not exceed 725 deg. F. Limiting the superheat, of course, advances the dew-point in the turbine, and unless certain precautions are taken there will be considerable condensation in the lower stages. To minimize this condensation, the machine may be divided into two units, as at the North Tees Station in England, and the steam resuperheated before use in the low-pressure element of the turbine.

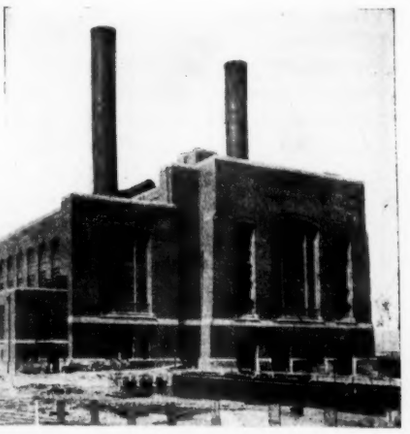
The first station in this country in which it was decided to employ a pressure in excess of 350 lb. gage, is the Waukegan plant of the Public Service Company of Northern Illinois. Here pressure at the boiler will be 400 lb. and 350 to 375 lb. at the turbine throttle, the steam temperature here approximating 700 deg. About the same time announcement was made of the Grand Tower station of the Middle West Power Co. using the same pressures and temperatures and a little later word came of the new Philo station of the Ohio Power Co., in which it is proposed to install boilers designed for a working pressure of 650 lb. gage, although they will be operated at 550 lb., giving a pressure at the turbine throttle of 530 lb. and a temperature of 725 deg. F.

Notable Power Plants Put in Service

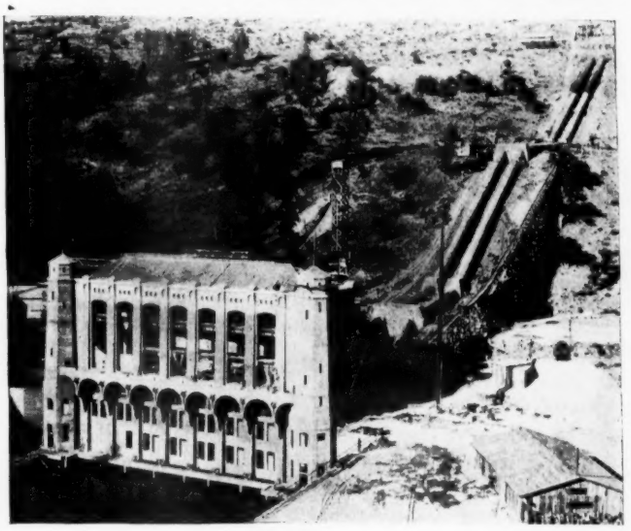
Below, Calumet Station of the Commonwealth Edison Co., Chicago. Initial installation contains two 30,000-kw. turbines. Boilers of 15,089 sq.ft. of heating surface are designed for 350 lb. steam and 250 deg. superheat. Steel economizers are installed. Authorization has been given to complete the plant for 200,000 kw. capacity.

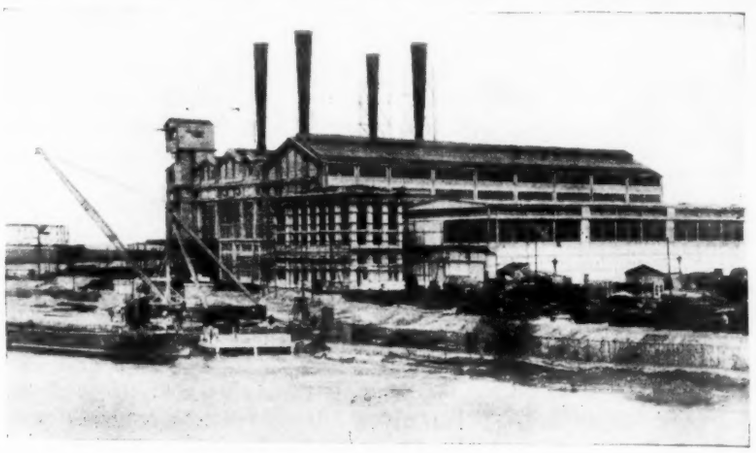


Above, Hell Gate Station, United Electric Light & Power Co., New York. Present installation contains two 40,000-kw. and two 35,000-kw. turbines. Steam at 250 lb. and 200 deg. superheat is supplied by twelve 18,900-sq.ft. boilers, double-fired with underfeed stokers. The ultimate capacity of the plant will be 300,000 kilowatts.



Below, airplane view Marysville Station, Detroit Edison Co. This plant contains the largest boilers yet installed, 29,880 sq.ft. of heating surface. Four of the boilers are to supply the initial installation of 40,000 kw. in turbine capacity. This installation is practically complete and plans are under way to add another unit.





Above, Pitt River No. 1, hydro-electric plant of the Pacific Gas & Electric Co., which has a capacity of 70,000 kw. This is the third plant of seven to be built on Pitt River, on which 600,000 hp. will eventually be developed. Power is generated at 11,000 volts and stepped up to 110,000, but later this will be raised to 220,000.

Left, Gennevilliers station, Paris. Present capacity 200,000 kw. in five units. Ultimate capacity 320,000 kw. Five double-ended 22,600-sq.ft. Stirling and 10 single-ended 14,300-sq.ft. cross-drum boilers supply steam to the turbines at 313 lb. gage and 280 deg. superheat. Ten-stage impulse turbines have a water rate of 9.45 lb. per kilowatt-hour.

Compared to the foregoing, European practice favors 350 lb. and 750 deg. F., although in one plant, the North Tees Station in England, a boiler pressure of 475 lb. indicates a tendency to higher steam pressures and temperatures. In Germany Dr. Wilhelm Schmidt has demonstrated that it is feasible to generate and utilize steam at pressures of 800 lb. and higher in reciprocating engines of special design, with a probable gain of 20 per cent in efficiency as compared to the best turbine practice prevailing. A steam consumption of 5.12 lb. per indicated horsepower-hour was obtained with a 150-hp. engine.

Theoretical gains and mechanical possibilities, however, vary from commercial application in that the latter must hinge mainly on net gain, which in turn depends upon increased cost. In a recent paper before the American Society of Mechanical Engineers, George A. Orrok, basing his conclusions on these premises, expresses the opinion that steam plants of 1,200-lb. and 750 deg. F. total temperature are justified as coming commercial developments. He would employ a regenerative cycle in which the feed water is successively heated by a series of bleeder heaters covering the entire range of temperatures from condensate to boiler water. (See *Power*, page 684, Oct. 31).

In contradistinction to the use of a single vapor and operation over a large temperature range, it has been pointed out that high efficiencies may be obtained more readily by using two vapors in series, such as mercury and steam. Intensive study is still being given the mercury turbine and boiler by the General Electric Co. and there is promise of a successful prime mover with an efficiency comparable with that of the Diesel engine. A 1,000-kw. unit is now being installed at the Dutch Point station of the Hartford Electric Light & Power Co. to operate under actual load conditions. Here the mercury-vapor pressure will be 37 to 38 lb. and exhaust from the turbine at 28 in. vacuum, with a corresponding temperature range of 850 to 650 deg. for the mercury vapor.

With such decided interest in higher pressures it has been necessary to extend the steam tables in current use, particularly for the higher ranges. In addition a thorough recheck of values is being made, and at some date in the near future it is hoped that the properties of steam will be known over a range wide enough for practical use for all time to come and accurate to a refined degree.

Station Heat Balance Still an Unsettled Question

IN LARGE stations operating at a high load factor the heat balance is still a question of leading importance. In solving this problem, there are almost as many methods as there are plants. For the smaller stations with comparatively low load factors less investment is warranted and the rule is simple systems in which the auxiliaries are driven by steam or partly by steam and partly by electric motors taking their current from the main units, the division being such that a proper selection can be made of each type of drive to maintain the heat balance at different loads.

In the larger plants driving all auxiliary equipment by electric motors and bleeding the main turbines at one or two points for feed-water heating, is now accepted generally as the most efficient method, considering the plant as a whole, the current being taken from the main units instead of the house turbine, which apparently is losing favor.

While considering heat balance, the heat losses in large turbo-generators cannot be overlooked. Even the generator losses amount to 5 to 7 per cent of the net output. In England Parsons proposes to recover the heat equivalent of these losses by circulating condensate through pipes placed in the generator core. In this country circulation of condensate through coils under the generator frame is being tried out in at least one installation. The generator cooling air in a closed circuit is to be passed over these coils in order that much of the heat loss may be recovered.

Other methods of conserving heat is to use condensate in the oil cooling coils and in the case of turbines with steam seals to recover the heat in this steam by passing it through a closed heater with condensate on the other side of the tubes. In two of the late stations in England, combustion air is preheated to about 200 deg. F. by heat from the flue gases. Air preheaters are used also at the Gennevilliers superpower station in Paris, where the flue gases are lowered in temperature to approximately 300 deg. F. and the air temperature is raised from 85 to 195 deg. for use in the boiler furnaces. This station has the additional features of step-by-step feed-water heating with steam bled from two successive stages of the turbine and a closed cooling circuit for the generators.

Steam Boilers and Superheaters Have Again Increased in Size

IN THE larger stations of the country the average boiler size is standardizing between 14,000 and 19,000 sq.ft. of heating surface. It has been pointed out that from 5,000 to 18,000 sq.ft. of surface there is a gradual decreasing cost per unit of rating.

To keep pace with the increased capacities at which these larger boilers are operated, furnaces are becoming larger in order that increasing quantities of coal may be burned efficiently and completely within the furnace. At 200 per cent of rating provision to burn two to three pounds of coal per hour per cubic foot of furnace volume is becoming standard, and under peak load conditions double this quantity of fuel may be consumed at good efficiency. In powdered-coal furnaces volumes are practically double, a common provision being to allow one cubic foot of furnace to one pound of coal burned per hour. Such proportions, of course, afford more protection to the brickwork and tend to reduce tube trouble.

With the large furnaces and therefore higher walls and the higher furnace temperatures existing, better brickwork and in particular improved methods of construction have been necessary. Furnace walls are being made thicker and in some cases of solid firebrick. Bonding tile in these walls anchored to steel members on the outside have been useful in holding the walls in line, and for stability the walls frequently slope away from the fire.

Much attention is being given to the effect of clinker erosion on brickwork and methods of preventing clinker adhesion. For this purpose the use of perforated blocks along the clinker line, through which air is blown from the stoker air duct, is becoming popular. Air-cooled blocks with no perforations are used in a number of plants, and a rotary plate set in an arched recess in the side wall at the point exposed to the greatest heat, to

keep down the formation of clinker, has been designed. The device is driven from the stoker crankshaft. It has been used successfully at the Port Morris station of the New York Central Railroad. With chain-grate stokers water-cooled members along the side walls, either cast-iron rectangular boxes or two runs of pipe joined by manifolds are being used. As these elements are connected into the circulation of the boiler, they form additional heating surface to absorb the radiant heat of the fire. In reducing furnace temperatures to some extent, they also are a factor in preserving refractories.

Owing to operation maintained at these high ratings and to the higher steam temperatures employed, it has been necessary to give careful attention to the baffling and to the protection of the brickwork in the furnace. As an aid in this direction all recent designs of large boilers expose the lower rows of tubes to the fire in order to absorb readily the greatest amount of radiant heat and thus reduce furnace temperature while incidentally improving the efficiency of combustion.

It has been found desirable to locate the superheater nearer the fire and in some cases remove it entirely from the path of the gases to absorb only radiant heat. A case in point is the Cumberland plant of the Kelly-Springfield Tire Co., in which the superheaters are set in the front walls of Stirling boilers containing 7,406 sq.ft. of heating surface. On these units considerable variations in load were anticipated. At the higher ratings it was the assumption that the lower efficiency would require more coal per pound of steam, so that the gas velocity increase would be above the increase in steam supply.

Another installation of the radiant superheater is to be found at Lansing, Mich., in boilers having 15,000 sq.ft. of surface. In some quarters there is a tendency to question the degree to which the superheat can be controlled in this type of superheater and the possibility of wide variations. On the other hand, most favorable results are reported from the new Foster radiant superheater made up of seamless steel tubes fitted with solid cast-iron rings, the gills of which are flattened on the furnace side. This superheater is built into the rear furnace wall facing the stoker.

Of the new boilers brought out during the year, the Adams is an arrangement of the bent-tube boiler designed to give the maximum surface in the first bank by using the longest tubes possible, set at the greatest inclination the headroom will allow. An outstanding feature is the downward travel of the gases along the tube surface in the first pass. The Page cross-drum boiler also is a new design with a number of refinements differing from existing types.

In design a radical departure has been made in the high-pressure boilers being built by the Babcock & Wilcox Co. for the Waukegan and Grand Tower stations. Practically a new type is to be constructed which will be suitable for considerably higher pressures than the 400 lb. to be generated in these plants. The new boilers are of the inclined header type with double-decked sections, the lower section being made up of 3½-in. tubes exposed for their full length to the radiant heat of the furnace and the upper sections of 2-in. tubes with a single baffle, making this part of the heating surface two-pass. Between the sections are the superheater loops. An economizer of transverse tube design built for a working pressure of 450 lb. is placed at the rear of the boiler setting and arranged for counterflow of the water and gas. In either plant forced-draft chain-grate stokers will be used. From this boiler highly efficient results are expected.

In addition to the typical stayed water-leg type of boiler it has built for years, the Heine Boiler Co. is branching out into designs that will permit of larger units, such as a vertical bent-tube boiler and a cross-drum sectional-header horizontal straight-tube type. Of the former three 15,000-sq.ft. boilers designed for a working pressure of 275 lb. gage are being installed for the City of Lansing, Mich., and two of the cross-drum boilers of 12,750 sq.ft. are ready for operation in Northeast Station at Kansas City. These boilers were designed to operate at 300 lb. pressure and have a number of features differing from standard practice, such as triple-decked tube sections.

Another interesting development is the boilers for the new Marysville plant of the Detroit Edison Co. They are similar to the W-type Stirling boilers used by this company except that the arrangement of the tubes and the baffling have been changed to some extent as a result of a most elaborate series of tests conducted at Connors Creek. Incidentally, they are the largest boilers in the country, containing 29,880 sq.ft. of steam-making surface. This is 60 sq.ft. in excess of the surface contained in the large boiler installed in the Congress Street Station by the same company to supply steam for heating and 3,410 sq.ft. more than is contained in the River Rouge power boilers of the Ford Motor Co., which formerly held the record in size. At Marysville four of these big units are to supply an initial installation of 40,000 kw. in generating capacity.

A new development for high-pressure steam generation is the experimental boiler installed at the Municipal Gas Co. plant at Albany, N. Y. It is operated at 225 lb. pressure, but is readily adaptable as a generating unit for 1,000 lb. per sq.in. The boiler was designed by the Power Specialty Co. with the co-operation of Thomas E. Murray, Inc. Both boiler and economizer contain 2-in. seamless steel tubes aggregating 1,000 and 825 sq.ft., respectively. These areas correspond to bare-tube heating surface, the actual areas being increased to 6,000 sq.ft. in the boiler and 5,000 sq.ft. in the economizer by means of "gilled rings" shrunk on the tubes themselves. The economizer delivers water to the boiler at approximately steam temperature, and the latter adds the heat of evaporation.

Stoker Design Improving

IN THE stoker field a feature was the number of consolidations of stoker-manufacturing interests. Considerable advance has been made by improving existing types and adding details which increase the efficiency of operation or facilitate manipulation of the stoker. The forced-draft chain grate has been simplified to a considerable degree, and where desirable, surfaces are being machined to make the compartments air-tight. Stokers of this type built to the great width of 24 ft. to eliminate the center wall formerly placed between twin stokers serving a single boiler, are being tested thoroughly in the plants in which they have been installed. Results favorable to this construction may be anticipated, as the same type of stoker 27 to 30 ft. wide is under consideration for several plants.

Several new hand stokers have been launched, and publicity has been given to two new types of underfeed stoker. One of these is a so-called "lateral retort"

stoker, consisting practically of two multiple-retort stokers arranged back to back so as to form a main retort between them from the front wall to the bridge wall, with lateral retorts branching off at right angles. In the other new stoker one of the important features is independent control of the air supply to the thick central part of the fire and to the thinner parts on the inclined grates at the sides.

In this field perhaps the most spectacular installation of the year is that of the Riley superstoker at Delray. This enormous underfeed, weighing 65 tons, has thirteen retorts and a total grate area of 470 sq.ft. In general design it does not differ materially from standard, but the entire mechanism is larger and heavier throughout. It replaces a double stoker setting under a Type W Stirling boiler of 23,654 sq.ft. effective heating surface and makes possible a big reduction in the overhead bunkers and coal-conveying equipment required by the old arrangement of a stoker at each side of the boiler.

Individual motor drive continues in favor and remote control is being employed to a considerable degree. A new application has been made of the Reeves variable-speed transmission. By coupling it with an ordinary type of pressure regulator, an apparatus is secured for automatically changing the speed of the stoker according to changes in the steam pressure. A new steam drive for stokers in the form of a governor-controlled turbine has been perfected. The governor is driven through a cone-and-belt variable-speed transmission, whose belt may be shifted by a handwheel or by means of automatic control. The speed range of the main driveshaft is 100 to 400 r.p.m.

Coal Production Lowest in Years

OWING to the five months' strike of the miners the coal production naturally has been the lowest in years. Estimates by the United States Geological Survey place the cumulative production of bituminous coal last year to Dec. 2 at 365,387,000 tons. With the weekly output running from ten to eleven million tons, the final figure for the full year should exceed slightly 400,000,000 tons. For the same period as given above, statistics show that the production is 3 per cent less than in 1921, twenty-eight per cent less than in 1920, fourteen per cent less than in 1919 and thirty-two per cent less than in 1918, when the output for the first 48 weeks of the year reached 540,196,000 tons.

An event in this field was the appointment of the Federal Coal Commission, whose purpose is to lay bare the whole truth about the coal industry and if possible bring harmony out of chaos. Unfortunately, its period of service is short and there is need for a permanent commission to promote a friendlier feeling between employers and employees, to stabilize working conditions and output and to guard the interests of the public in so vital a matter as fuel. It has been stated that stabilization of the industry would eliminate fully one-third of the national coal bill. With capacity sixty per cent in excess of normal demand and three-day weeks alternating with periods of shortage and extortionate prices, it is quite evident that there is need for more engineering and less bargaining.

It is interesting to note that a new classification of coal has been proposed by Prof. S. W. Parr, of the University of Illinois. Previously, the most significant classifications have been based upon the ratio of volatile matter to fixed carbon in the fuel. Instead, Professor Parr would base his classification on the heat value of pure coal and the percentage of volatile in the pure coal, getting in this way a classification related only to the coal substance and not dependent upon accidental variations in ash or sulphur in the sample tested. Thus the coal itself and not the impurities carried is the basis, and it has been found that by this formula very reliable results have been obtained.

Another event of the field is the fact that Trent process fuel is now commercially available. As may be recalled, the Trent process consists in powdering a poor grade of coal and mixing it with oil and water. The combustible part of the coal has an affinity for the oil and forms an amalgam with it, while the ash separates out and stays in the water. The result is a high-quality fuel which may be burned as such or first distilled to recover the oil.

Quite similar is the emergency fuel proposed by the United States Bureau of Mines during the coal shortage threatened in the summer months. It is a simple mixture of fuel oil with fine coal, as much oil being used as the coal will absorb and hold. The mixture may be effected by means of a shovel or concrete mixer. Slack coal having a high percentage through an 8-mesh screen, or which may be crushed to sizes of ¼ in. or less, will take up in oil from 30 to 40 per cent of its own weight and make a fuel high in calorific value. The finer the coal the more oil it will hold. Bituminous slack and anthracite culm are adapted equally well to the process. In the course of experiments in North Dakota the Bureau has produced also a lignite fuel at a cost comparable with that of domestic sizes of anthracite in Pennsylvania. It is understood that plans are under way to manufacture this fuel on a commercial basis.

Powdered Coal Is Being Considered Favorably for Many Plants

THE use of this fuel has received considerable impetus during the last year by the decision to equip a second large central-station plant for the burning of coal prepared in this way and the installation of a number of smaller industrial plants, as well as equipping an experimental boiler in some of the large central stations. More compact drying and pulverizing equipment that may be placed in the boiler room is being sought, and in some plants where coal with a moderate amount of moisture is available, the driers have been omitted entirely. Typical examples are the River Rouge station of the Ford Motor Co. and the converted two-boiler installation of the Rochester Gas and Electric Co. Here the pulverizing equipment and the coal bins are directly above the boilers. Conveyors, being the only equipment that might fail to function owing to moisture, are omitted. From the cyclone the powdered coal flows by gravity through the storage bunker to the feeders supplying the burners. Following recent tendencies, the furnaces are of the ventilated hollow-wall type, the cooling air being used as preheated excess in the combustion chamber. One operator handles both boiler and pulverizer. This installation is extremely simple and thus along desirable lines.

In all recent powdered-coal plants similar methods of furnace-wall ventilation are being employed. At the new Eline plant in Milwaukee the cooling air is discharged into the boiler room. At Lakeside water

screens to protect the brickwork by lowering furnace temperature and to prevent the formation of slag have been perfected to a high degree. Radiant-energy superheaters also might help to solve the same problems. Improved methods of trapping the finely divided ash in the flue gases are desirable, and additional economies might be effected by utilizing the flue gases to dry the coal. Such procedure would save the fuel otherwise burned under the drier and improve the efficiency of burning in the boiler furnace.

This plan is to be followed in the new Cahokia Station of the Union Electric Light and Power Co. in St. Louis. Eight boilers, each containing 18,000 sq.ft. of steam-making surface, and two 30,000-kw. turbogenerators will comprise the initial installation of a plant that ultimately will contain eight of these units. Steam will be supplied to the throttle at 300 lb. absolute and a temperature of 690 deg. F., the boilers being arranged for 350 lb. pressure. The fuel-preparation plant will be located in the boiler room rather than in a separate building, the advantages gained being a more compact plant of lower cost and a simplified conveying system.

Use of Oil as Boiler Fuel Increasing

AT THE beginning of the year refineries had in storage an enormous amount of fuel oil and as the production of gasoline continued, the storage of this residue or byproduct did not decrease. Naturally, the price of this commodity dropped to a low figure. With a coal shortage threatening during the summer months, a great many power plants, particularly in the eastern section of the country, turned to oil as a fuel, and unless the fiasco of three years ago is repeated, will continue to use this fuel so long as its cost is below that of coal, taking into consideration, of course, the advantages presented by a liquid fuel. Fundamentally, it is wrong to use a limited resource in this way so long as more abundant fuels are available, but conservation of petroleum resources must come, if at all, by using less gasoline or by recovering a larger percentage of it from the crude oil, and not by limiting the use of the residue.

Of the hundreds of plants adopting fuel oil, conspicuous examples are the plant of the Amoskeag Manufacturing Co. of Manchester, N. H., where 64 vertical fire-tube boilers of 1,500 sq.ft. each are now burning oil, and the 20,000-kw. station of the New York Central at Yonkers, where the change-over on six of the twenty boilers in the plant was made in a comparatively short period of time. In the Singer Building, New York City, two years' operation with fuel oil showed a thirty-four per cent saving over coal and the installation paid for itself in 21 months.

Domestic consumption of petroleum for 1922 is estimated at 570,000,000 barrels and domestic production at 545,000,000 barrels, leaving a balance of 25,000,000 barrels which came from imports principally from Mexico. The figures in respective order for 1921 are 525,000,000, 470,000,000 and 55,000,000 barrels.

Little Interest in the Smoke Problem

WITH the substitution of grades of coal different from those supplied under normal conditions, the use of inferior coal and a slackening on the part of officials, the smoke situation is bad and in fact has been for years. Attention has been concentrated on securing enough fuel to keep going. The City of Grafton, W. Va., therefore, is to be congratulated on its co-operative effort with the Bureau of Mines to study its smoke problem. It is probably the only city in the country giving serious attention to this question.

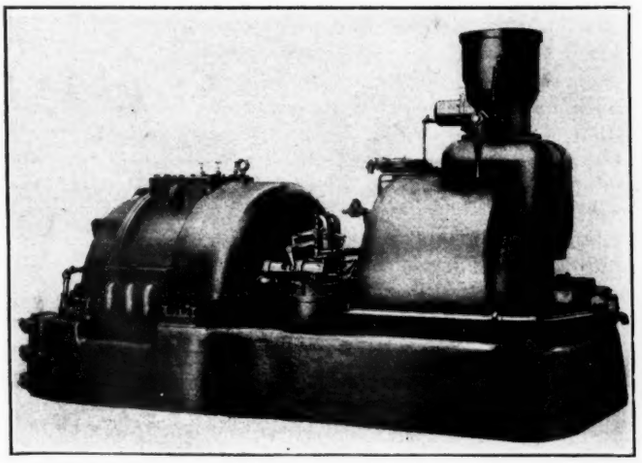
Coal and Ash Handling

IN COAL handling an interesting development of the year is the application of the caterpillar tread to portable coal loaders and to gasoline-operated locomotive cranes, the latter giving a simple and comparatively inexpensive means of unloading and storing coal for the smaller stations and proving useful as a temporary outfit for large plants, an equipment of this character having been used at the Hell Gate station for some time. Another portable outfit has been designed by mounting the crane on an ordinary truck chassis. Pneumatic handling of coal is being tried out in London.

In favorable locations the hydraulic sluicing of ashes is being adopted. The system is simple and convenient, as it simultaneously quenches and conveys the ashes to the desired location. Typical examples of its use are in the Hell Gate station and the new Brooklyn Edison plant.

Turbine Improvements

THE steam-turbine development has been memorable as to diversified improvement. Large units which are subjected to the most exacting demands, rapidly changing designs and severe steam conditions, are being improved with special regard to increasing service

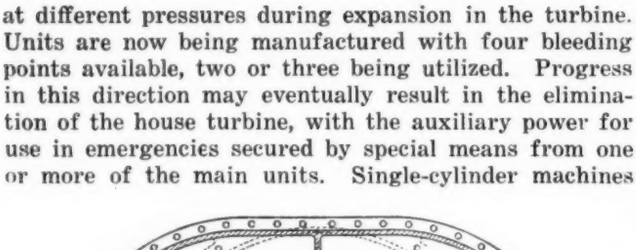


RATEAU-BATTU-SMOOT 3,000-HP. TURBO-BLOWER WHICH OPERATES AT 10,000 R.P.M.

reliability; in spite of the stress laid on dependability, confidence is such that the single-cylinder unit has been notably increased in size, and steam pressures raised. Small and medium-sized turbines also present some new developments.

Business is extremely active in the field of large units, as 1,200,000 kw. capacity is now under construction for large central stations. In response to the demand for greater economy higher steam pressures are being utilized, while units at present are being built for 500 lb. per sq.in., 725 deg. F. It is realized that economy from high pressures is not especially effective unless a regenerative cycle of some sort is used, such as heating the condensate by means of extracting steam

at different pressures during expansion in the turbine. Units are now being manufactured with four bleeding points available, two or three being utilized. Progress in this direction may eventually result in the elimination of the house turbine, with the auxiliary power for use in emergencies secured by special means from one or more of the main units. Single-cylinder machines



STREAM-LINE EXHAUST CASING CONTAINING EIGHT CHAMBERS

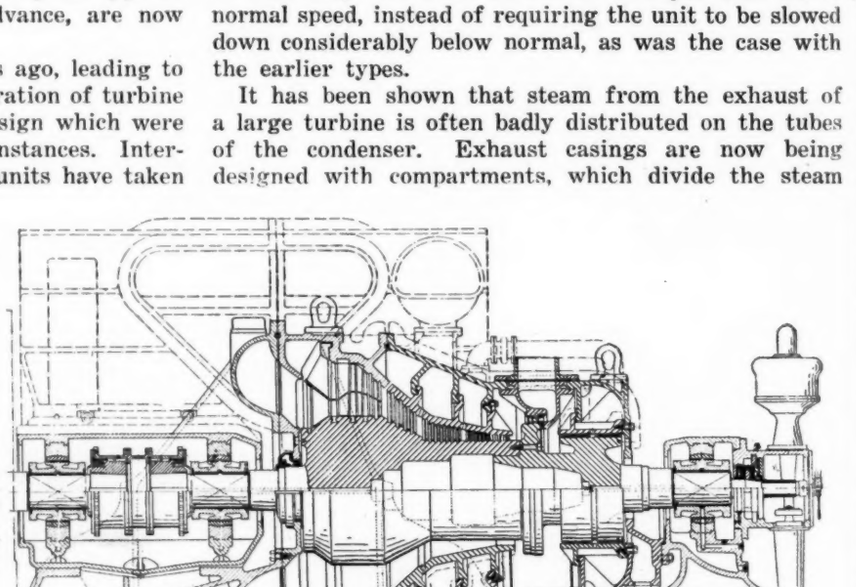
of reaction type of 30,000 kw. and the impulse type of 60,000 kw., representing a notable advance, are now being built.

Tests that were carried on two years ago, leading to better information in regard to the vibration of turbine wheels, have resulted in changes of design which were applied during the past year in many instances. Interesting changes of blading of reaction units have taken place; units that use the shroud-ring type of blading have recently been designed with close axial clearances instead of small radial clearances in the high-pressure stages, the lower-pressure blading being of the usual radial type clearance. This is the result of extensive experiments and is reported as having shown gains in economy and facility of adjustment. The Bauman type blading has been adopted in other large reaction units. This was originated at the Metropolitan Vickers Electric Co. of England, described in *Power*, Feb. 7, 1922, and bypasses part of the steam through openings in the lower part of the low-pressure blade, leading this to other rows of blades for use. It is possible to make a single-flow turbine with double or triple rows of low-pressure blading at the last expansion, taking the place of a double-flow machine. A further economy in large machines has been made by eliminating the "barrels" of the high-pressure blades, or in other words sections of the blading where several rows of the same length exist; instead, a conical steam passage is used, so that each succeeding row of blades is somewhat longer than its predecessor. This eliminates the losses due to eddy currents in steam incident to barrels. By using two or more rows of blades in the last stage of the low-pressure cylinder, it is possible to use a single-flow turbine where a double-flow type was originally necessary. This permits the use of a single condenser opening, which is appreciably better than two openings required by a double flow.

In some types of large turbine units special provisions have been made for quickly coupling or uncoupling the generator from the turbine. This greatly assists when the generator is run as a synchronous motor, disconnected, and it is desired to make a quick change for connecting to the turbine. Turbine-driven auxiliary oil pumps have been more widely applied for large units. Provision has been made in a few instances for cooling the circulating oil with condensate. A small amount of heat is reclaimed in this way, but the great advantage lies in clean cooling water, which makes it seldom necessary to clean the oil cooler itself.

Governors have not been appreciably changed, but emergency governors have seen further improvements along the lines of making a test possible without overspeeding the unit. An emergency valve gear has recently been developed which can be tripped at the normal speed of the turbine by oil under pressure. Measuring the pressure of the oil is a measurement also of the ability of the emergency to trip at the proper speed. In other words, a certain gage pressure should trip the governor at the normal speed of the turbine, if properly adjusted. Emergency governors in general are using a much shorter regulation than previously, so that they will reset at one or two per cent above normal speed, instead of requiring the unit to be slowed down considerably below normal, as was the case with the earlier types.

It has been shown that steam from the exhaust of a large turbine is often badly distributed on the tubes of the condenser. Exhaust casings are now being designed with compartments, which divide the steam equally and deliver it in a uniform manner on the tubes of the condenser underneath.



BAUMAN TYPE TURBINE BLADING USED ON LOW-PRESSURE END WESTINGHOUSE TURBINE
Stream-line exhaust chamber is indicated in dotted line

A notable development in high-speed turbines is the turbo blower which operates at 10,000 r.p.m., delivering in the neighborhood of 3,000 hp., normal load, consisting of three impulse-type wheels, 16 in. in diameter.

There has been one new manufacturing company to begin business in the field of small turbines, and several new lines have been manufactured by other companies. Improvements include the elimination of fiber packing

glands on balanced governing valves in some cases, and the addition of a restraining ring in some types of high-speed units, which prevents the rotating body from leaving the casing in event of overspeed.

In the field of bleeder or extraction turbines a new type has appeared, which automatically regulates the pressure in the extraction chamber. The valve that controls the flow of steam to the low-pressure stages is regulated by a hydraulic gear, producing practically constant pressure at the point where steam is extracted, with the addition of special control of inlet pressure and number of active nozzles.

Condensers

SOME changes, relating chiefly to the more efficient operation of surface condensers, have taken place. It has been established that steam is often discharged unequally on the tubes of a condenser and that some parts of the cooling system do much more work than other parts. Better distribution of the steam has been brought about in some cases by arranging the tube spacing in a more suitable manner. The air baffle has been arranged to utilize the cooling effect of a larger tube surface, producing cooler non-condensible gases, requiring less effort in removing. Another improvement relates to the means of exhausting air so that less steam will be drawn into the air-collecting baffle. The flow of condensate is arranged to assist in preventing such a condition, and ample opportunity is given for air to release itself from the condensate and rise to the baffle. This also results in lowering the temperature of gases extracted by the dry pump, so that considerably less power is used. Attention has been drawn to the necessity of small uniform grain in condenser tubes as being conducive to longer usage. Surface condensers have been increased in size to units of 100,000 sq.ft. of cooling surface.

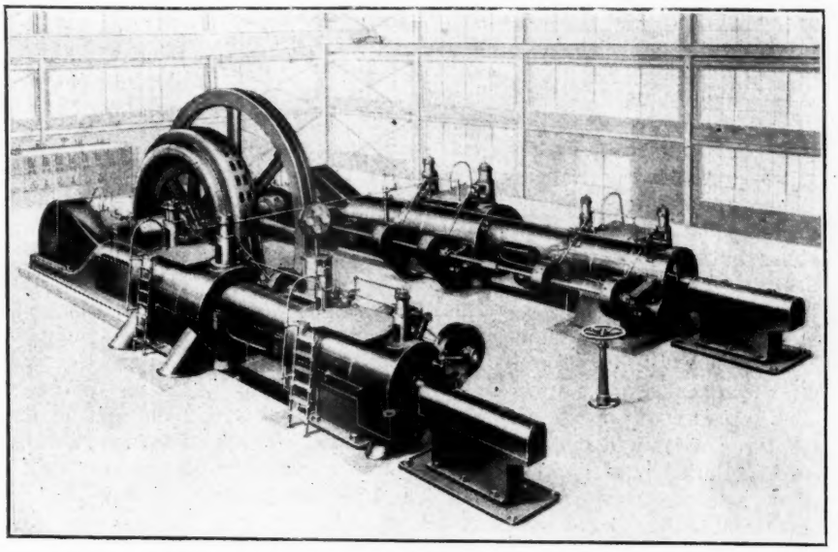
Evaporators Gain in Favor

IN LARGE plants where operation at high rating is the rule, evaporators to supply pure makeup water continue to gain in favor. In many of the later plants evaporators form part of the equipment, and their use is being extended to smaller plants, although in simplified form in order that the initial cost may be held to a low figure. In the stationary plant the type of apparatus more commonly used is the two-effect high-pressure evaporator, although in a certain locality where the raw water is rich in scale-forming ingredients, a quadruple effect is in use. At the Colfax and Springdale stations low-pressure evaporators are employed, and in the Navy a change from the high- to the low-pressure equipment is being made in order that the temperature may be below the scale-forming point and the encrusting solids blown off in the form of a sludge. The exhaust steam utilized is from the auxiliaries which formerly were operated condensing, so that the heat previously thrown away in the condenser cooling water is conserved. Also less heat is thrown overboard in the blowdown.

Notwithstanding the improvement in the quality of the water obtained by the use of the evaporator, it was discovered that other factors had to be considered, such as the pitting of boilers and particularly steel tube economizers, so that some apparatus had to be supplied to insure the complete removal of oxygen and carbon dioxide from the boiler-feed water. Several such gas removal equipments now on the market have obviated this difficulty.

Steam-Engine Developments

THE steam engine has failed to fulfill the prophecy made some years ago that, owing to the inroads made by the steam turbine and internal-combustion engine, the reciprocating steam engine would ultimately disappear. To the contrary, there has been a marked revival of interest and many reciprocating engines have been installed in plants where a few years ago other types would have been given the preference.



ALLIS-CHALMERS 4,200-HP. TWIN-TANDEM COMPOUND DROP-PISTON VALVE STEAM ENGINE

It is unquestionably true that the reciprocating engine will never again be generally installed in central stations, the increase in capacity per unit making the engine impossible. However, as the events of last year illustrate, there are many plants where engines of large capacity are the logical choice. This is especially true as to steel-mill work where the efficiency of certain types of reciprocating steam engines direct-connected to the rolls is superior to other steam prime movers where the power must pass through transformers, motors, etc. Because of these facts one steel mill installed a 25,000-hp. unaflow engine and finds that the almost uniform steam rate over a wide load variation gives the lowest attainable power costs.

The unaflow engine is now being built by fifteen manufacturers, and while the 1922 sales were approximately 50,000 hp., the horsepower actually installed was above this by reason of the carry-over from 1921.

Examination of the unaflow output reveals that a large percentage have gone into industrial plants, such as textile mills, which heretofore were using central-

station service or other prime movers. There was no great amount of new factories built during the year, consequently most of the engines were replacements. By reason of the renewed activity in industrials there is every hope that 1923 will show an increased interest in the unaflow engine. Attractive sales policies have assisted in promoting this type of engine, and this should be of greater influence in the coming year.

The slight decrease in sales in 1922 compared with 1921 has not been an unmixed evil. The designers and builders have as a consequence been able to devote time to the perfecting of details. Where formerly most of the builders followed the original unaflow engine designs rather closely, lately there have been found quite marked differences in the different engines, especially as to details of valve and valve gear.

Of recent development is the combination of the unaflow steam cylinder with the Humphrey's hydraulic pump. The work is being carried on in California, and apparently the cost of pumping water will be radically reduced by this arrangement.

Professor Stumpf has experimented with exhaust nozzles with the view of making use of the kinetic energy of the exhaust to reduce the cylinder back pressure. This has proved successful on the Prussian State Railways, and American builders of stationary unaflow engines are showing a deep interest in the subject. The vacuum possible with this arrangement would in many installations prove more economical than a high vacuum obtained at the expense of installing a condenser.

American railroads have been slow to adopt the unaflow locomotive construction, but at the present time one Eastern trunk line is preparing to build an experimental locomotive of this type.

The entrance of the unaflow has by no means eliminated the Corliss and poppet four-valve engine. These are being built by a number of firms and exceed the unaflow sales in horsepower totals. A 4,200-hp. twin-tandem-compound drop-valve engine with Corliss detaching valve gear was installed in a corn syrup factory during the year. This is the largest direct-connected engine-generator unit installed in recent years.

Valves and Piping

THE success of piping for high pressures has been confirmed, especially the use of the welded type of Vanstone joints. It is realized that very little is known of the flexibility of pipe bends, especially for high-pressure piping. Flexibility is much more important at high temperatures on account of the greater expansion taking place, and the greater stiffness of the pipe lines under high pressure. Experiments and calculations in pipe-bend flexibility were made during the last year by the Detroit Edison Co., results of which were given at the annual meeting of the A.S.M.E.

Tests of valves under high pressures during the last year indicate that a great deal is to be desired in the quality of the valves upon the market at the present time. In testing for closing under emergency conditions, it appeared that the closure was effected satisfactorily, but in many cases more or less damage to the valve seat appeared probable. The use of higher pressures and temperatures appears to depend mainly on the production of suitable valves, and the need of development along this line has been greatly emphasized.

Pumps and Blowers Improved

IN PUMPS as well as other power-plant equipment certain advances have been made and new types have made their appearance such as the Bethlehem-Weir turbo and reciprocating pumps for boiler feeding, and the De Laval multi-stage "series" pump for high-pressure work. In air-compressor design the adaption of uniflow principles to the steam end is a recent feature. An innovation in turbo-blowers for mechanical-draft applications is the new Rateau-Battu-Smoot machine in which four impellers are arranged to operate in parallel. They are of the helicoidal type, two being mounted on a common shaft to form a blower, and one of these elements is placed on either side of a central driving turbine. Since the characteristics of the blowers are such that when the discharge opening is reduced, the air pressure goes up in a proportion that maintains the power consumption of the turbine practically constant, no governor is required on the turbine and its speed remains nearly uniform. In forced-draft applications this characteristic is desirable, since when the fire develops conditions that tend to reduce the air supply, the blower pressure increases automatically and tends to maintain the air volume constant.

Better Metering Facilities

WITH fuel high in price and scarce for the greater part of the year, activity in the meter field has continued. Several new meters have appeared and older types have been perfected to make them more accurate or to give a different combination of readings on the same chart. Two new flow meters have arrived, one an electrical instrument and the other employing a tilting U-tube suspended on a knife-edge like a beam balance, the flow being measured by the amount the tube tilts owing to the rise of mercury in the low-pressure arm and the corresponding fall on the high-pressure side. An electrical instrument has been devised to show quickly the concentration of boiler water by measuring its electrical resistance.

An air-flow meter depending for its action upon the movement of a small vane suspended in the current of air has been designed and also a CO_2 indicator entirely mechanical in operation, making no use of chemicals. The device is little more than a sensitive beam balance with a light airtight metal float on one arm and compensating weights on the other. Flue gas is heavier than air by an amount depending on the percentage of CO_2. Thus when a sample of flue gas is injected into the box containing the balance, the buoyancy of the air float in the denser atmosphere of the flue gas causes it to rise, and the pointer of the balance on a suitably calibrated chart indicates the percentage of CO_2 in the gas. Other developments given publicity are an ingenious feed-water weighing meter, a new damper regulator, improved forms of draft gages, a new form of temperature regulator consisting of a pipe thermostat coupled to the usual expansion element and a most complete centralized combustion control system for boilers. It can be applied to one or a number of boilers and their operation regulated automatically from a master controller, the object being to maintain the character of combustion to give the best boiler efficiency for all conditions of load. By transmission of any variation in steam pressure through the master regulator to auxiliary regulators the volume of coal and air is altered to meet the changed conditions in the various furnaces.

Notable Steam-Power Plants Placed in Operation or Being Built

IN THE central-station field expansion was never more active. In fact, during the year so many new plants of large size have been projected and additions proposed for existing plants that space will not permit a complete enumeration. Reference already has been made to the three plants in which boiler pressures will exceed past limits by a considerable margin. In the Waukegan plant of the Public Service Company of Northern Illinois three boilers of the design previously outlined, containing 14,086 sq.ft. of steam making surface, 2,485 sq.ft. in the superheater and 8,837 sq.ft. in the economizer, are going in. The boilers will operate at 400 lb. gage and will have maximum capacity to generate 150,000 lb. of steam per hour superheated to 700 deg. F. Forced-draft chain-grate stokers 21 ft. wide by 18 ft. 3 in. long serve the boilers. A grate area of 383 sq.ft. gives a ratio to boiler-heating surface of approximately 1 to 37.

At the Grand Tower plant of the Middle West Power Co. the boilers are to be almost identical, except that they are a little smaller in size, each unit containing 11,600 sq.ft. of steam-making surface, 7,000 sq.ft. of economizer and 2,700 sq.ft. of superheater. An ultimate generating capacity of 100,000 kw. in four units is to be installed. All condenser auxiliaries are to be motor driven, and steam at 8 lb. pressure is to be bled from a lower stage of the turbine to heat the feed water.

At the Philo Station of the Ohio Power Co. where an operating pressure of 550 lb. is to be carried, the boiler, superheater and economizer designs are again similar to the Waukegan units. An initial installation of 70,000 kw. in two units is to be made, which is one-third of the ultimate capacity of the plant.

For the Calumet station of the Commonwealth Edison Co. authorization has been given to complete the plant as originally outlined; that is, adding four more units to an initial installation of two, so that a total generating capacity approximating 200,000 kw. will be obtained. On the west side of the city at Crawford Avenue, the same company is planning an eight-unit plant to have a final capacity of 240,000 kw. or more, depending upon the size of the individual machines selected. The steam turbines for the two units first to be installed will be of the single-cylinder type and it is probable that boiler practice will follow closely that at the Calumet station. This will mean boilers approximating 15,000 sq.ft. operated to supply steam to the turbine throttle at 350 lb. pressure and 250 deg. of superheat.

Northeast Station at Kansas City is being extended to accommodate two 30,000-kw. machines and their complement of eight boilers. During the year one of these units has been made ready for service. Two 35,000-kw. units are to be added to the Springdale plant of the West Penn Power Co. To supply power to the Youngstown industrial district, the Pennsylvania-Ohio Power & Light Co. is planning to build a large station along the Ohio River near Steubenville. In Detroit, Mich., the Public Lighting Commission is to build a 150,000-kva. plant. Two-thirds of this capacity in four units will comprise the initial installation. The two units, aggregating 40,000 kw. in the Marysville Plant of the Detroit Edison Co. with their record-breaking boilers, are practically complete and plans are under way to add another unit. The company also has under consideration an entirely new station. In Boston the Edison Electric Illuminating Co. is planning the construction of a new plant at Weymouth. Two 30,000-kw. units are to form the initial installation of a 300,000-kw. plant.

At the Hell Gate Power Station in New York City production began during the year. Previous reference to these columns will show that the present plant contains four main turbines, two rated at 40,000 kw. and two at 35,000 kw. Steam at 250 lb. pressure and 200 deg. superheat is furnished by twelve 18,900-sq.ft. boilers double-fired with underfeed stokers. Eventually, there will be twenty-four boilers and eight generating units arranged in four independent groups to give a generating capacity of 300,000 kw. Incidentally, when all eight of these units are in operation, the circulating water used will amount to 800,000,000 gal. per day, which is 60 per cent more than the total water supply of New York City. With the exception of a few stand-by units, the auxiliaries are motor driven. A house turbine is part of the equipment, and bleeding from the main turbines is practiced to help maintain the heat balance. One of the unusual features for so large a plant is the hydraulic sluicing of ashes.

Construction has begun on the new 400,000-kw. station of the Brooklyn Edison Co. One-half of the ultimate building is to be erected, and for the time being two 62,500-kw. turbo-generators and eight boilers, each containing 19,650 sq.ft. of steam-making surface, are to be installed. Steam will be delivered to the turbine throttle at 265 lb. gage pressure and 200 deg. superheat. With the exception of one-third of the boiler-feed pumps all auxiliaries will be motor-driven. The condensate from the main generating units will be used to condense the exhaust steam from the house turbine, and the heat balance will be maintained automatically by bleeding the main turbine at two points into high-pressure and low-pressure closed heaters. In this plant also, hydraulic sluicing of the ashes from beneath the furnaces to an outside under-water storage pit will be a feature.

In comparison to the latest in American power-plant practice some mention of the great French superpower station now being completed at Gennevilliers, just outside of Paris, may be of interest. With a present capacity of 200,000 kw. in five units and an ultimate capacity of 320,000 kw. it is one of the world's largest power plants. Five double-ended Stirling boilers containing 22,600 sq.ft. of steam-making surface and ten single-ended 14,300-sq.ft. cross-drum boilers comprise the present boiler-room equipment. Each of the former is served by two underfeed stokers having a total grate area of 660 sq.ft. and the latter by four forced-draft chain grates having a total grate area per boiler of 394 sq.ft. Steam is delivered to the turbine throttle at a pressure of 313 lb. gage and is superheated 280 deg. F. to give a total temperature of 705 deg. These units are 40,000 kw. ten-stage impulse turbines having a water rate of 9.45 lb. per kilowatt-hour.

Among industrial plants new with the year, mention should be made of the American Sugar Refining Co.'s station in Baltimore. Here, five 12,060-sq.ft. bent-tube boilers equipped with twin forced-draft chain grates burning small-sized anthracite are installed. Furnaces designed to improve the gas mixture and decrease the carbon loss, with arches front and rear, are a feature, and from an engineering point of view the reasons back

of the installation of direct-current power equipment and of twin Corliss engines rated at 1,880 hp. as prime movers, in the face of the present tendency toward turbines, are of exceptional interest.

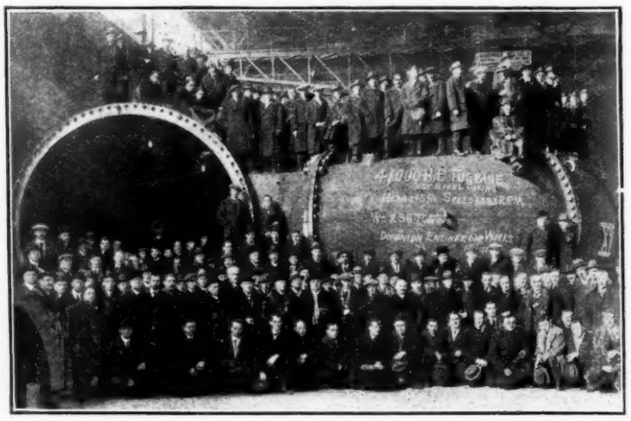
Almost complete utilization of waste heat is the feature distinguishing the new Kansas City plant of the Corn Products Refining Co. For the making of corn syrup, power demands for conveying and pumping are heavy and great quantities of exhaust steam are required in the processes. Careful planning made it possible to balance nearly the power steam with the demand for exhaust steam for process work and heating, and for such times when the two loads are not in exact balance, a feed-water heater has been equipped to take automatically any temporary surplus of exhaust steam. Thus on this end of the steam cycle conservation of heat is carried to the limit and at the boilers additional economy is secured by utilizing the gases of combustion for the drying of corn hulls. An exit temperature to atmosphere of 130 deg. F. for the gases is something not yet attained in any power plant even with the use of economizers and air preheaters. The plant contains four 5,000-sq.ft. boilers equipped with forced-draft chain grates and the largest direct-connected steam-engine generating unit (3,125 kva.) built in this country in over a decade. The conditions imposed were non-condensing operation against a back pressure up to 5 lb. gage, and were met by the installation of a twin tandem-compound Corliss engine with valves of the drop-piston type. Three-phase 60-cycle current at 440 volts is generated and the speed is 100 r.p.m. Evidently the Corliss engine still has its uses.

New Records for Size of Hydro-Electric Units Have Again Been Established

IN HYDRO-ELECTRIC development the activity that has characterized this part of the power field since the world war did not slacken in 1922. If anything, progress has been accelerated, owing to a five months' coal strike that threatened the industrial activities of the country. The passing of favorable legislation that created the Federal Water-Power Commission in November, 1920, has clearly indicated the practical value of the Federal Water Power Act. Even though by the end of 1921 the commission had received applications for water-power development aggregating 16,000,000 hp., the past year has seen over 5,000,000 hp. more added, making a grand total of over 357 applications representing over 21,000,000 hp. This amount is more than twice the existing water-power installations in the United States and more than six times the aggregate of all applications for power sites, under Federal control in the preceding twenty years.

Among the important applications made to the Federal Water Power Commission for permits during the last year, may be mentioned that of the Pacific Light & Power Co., Portland, Ore., to develop 650,000 hp. on Snake River; West Virginia Power & Transmission Co., to develop 500,000 hp. on the Cheat River in West Virginia and Pennsylvania; and the Utah Power & Light Co., to develop 800,000 hp. on the Green and Gampa Rivers. A license was granted to the San Joaquin Light & Power Corp., Fresno., Calif., to develop 266,000 hp. on the West and North Forks of the King River. This includes seven power houses, two of which will operate under heads of over 1,500 ft. and two under heads of over 2,300 feet.

Nearly one-half of the aggregate 21,000,000 hp. represented in the applications are upon the St. Lawrence, Columbia and Colorado Rivers, upon which no definite decision has been made as to their development. However, the last year has seen considerable discussion of these projects. The Joint International Water Ways Commission appointed by this country and Canada to investigate the feasibility of the two countries jointly developing the power of the St. Lawrence River, made a favorable report on the project. At this date



SHOP VIEW OF A 41,000-HP. HYDRAULIC TURBINE TO OPERATE UNDER A 145-FT. HEAD AT 138 R.P.M.

the project is being held up, awaiting action by the Canadian government.

On the Columbia River, which involves the States of Washington, Idaho and Montana, a board of engineers appointed by the Federal Water Power Commission, has made its report, and among the conclusions it recommends freedom should be given to the fullest irrigation expansion in the three states involved.

At the end of last year a commission was created by Congress and the seven Southwestern States bordering on the Colorado River to work out a comprehensive plan for the development of the entire river and make recommendations to Congress. Under the leadership of Secretary Herbert Hoover as chairman of the commission, a treaty has been entered into by the States of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming, which has solved one of the most perplexing problems standing in the way of power development on this river, involving about 6,000,000 hp. The commission adopted a resolution urging Congress to proceed toward the construction of the control works in the lower reaches of the river.

What shall be done with Muscle Shoals, war-time nitrate and power project, has commanded a great deal of attention during the last twelve months, even though it does not seem to be any nearer a solution than at the beginning of the year. Henry Ford's offer early in the year to take over this project brought forth numerous exponents both for and against the Ford proposition as well as counter proposals by other interests. A new bill is now before Congress, which proposes the creation of a body to be known as the Federal Chemical Corp. to complete and operate the project. Thus the year closes with four of the greatest water-power projects on the American continent, involving about 13,000,000 hp., still in political tangles.

Although these four projects have not reached the stage where a definite plan of development has been

decided on, in other locations construction work has been active. The Niagara Falls Power Co. has again taken the lead and has construction work well under way for the installation of three 70,000-hp. vertical-shaft reaction-type turbines, in another extension to Hydraulic Plant No. 3. These, when installed, will be the largest hydraulic units in the world and will increase the capacity of Hydraulic Plant No. 3 to 452,500 hp. This development involves the construction of a horseshoe-shaped concrete-lined tunnel 4,300 ft. long, 32 ft. diameter, three penstocks cut in solid rock and concrete lined, 21 ft. in diameter and 600 ft. long. The tunnel is the largest in the world for power purposes and is excelled only by the ship tunnel for the Rove Canal at Marseilles, France. These machines will use the water that is now being used in two of the older plants at the Falls, and will produce twice the power that is now obtained from the same water.

The first section of the Queenston Plant of the Hydro-Electric Power Commission of Ontario is nearing completion. This includes five 55,000-hp. machines. Some of these units have carried over 60,000 hp. load. When completed, the development will have a capacity of about 600,000 hp. and utilize 315 ft. of the 327-ft. fall between Lake Ontario and Lake Erie, and develop over 30 hp. per cu.ft.-sec. of water delivered to the turbines. What Niagara Falls means to this country and Canada is indicated by the fact that by the end of 1923 there will be installed and in operation, if present plans are carried out, 1,389,000 hp. and with the water available under the present treaty, will develop over 1,000,000 hp.

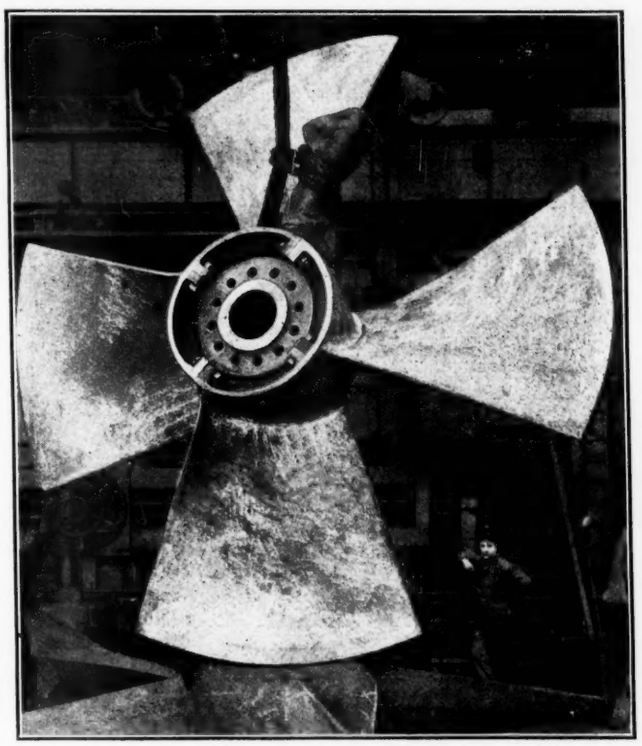
Another hydraulic turbine of special interest is the 41,000-hp. unit put in operation in the plant of the Shawinigan Water and Power Co. This machine operates under a 145-ft. head at 138.5 r.p.m. and in physical dimensions is the largest machine so far constructed. The two 28,000-hp. units for the Manitoba Power Co., Ltd., probably represent the most sensational development in hydraulic turbines during the year on account of being of the propeller type. Previous to this development this type of unit has been constructed only in small sizes. These units will operate under a head of 56 ft. at a speed of 138.5 r.p.m. It is interesting to note that although this machine is operating under approximately one-third the head of the Shawinigan unit, it operated at the same speed. These units, as well as the Shawinigan machine, were constructed by a Canadian company, and this company reports that it has under construction at the present time over 153,000 hp. in hydraulic turbines in orders that were taken during the last year. These include four 11,300-hp. units to operate under a 30-ft. head.

One of the most notable installations made in the United States during the year is that of four propeller-type turbines installed in the Green Island Plant of Henry Ford & Sons, on the Hudson River near Troy, N. Y. These units are normally 2,000-hp. capacity when operating under a head of 13 ft. However, the head varies between the limits of 4 and 17 ft. The wheels are placed in a siphon setting whereby the water level over the turbine can be raised about ten feet above the normal headwater level.

Other notable hydraulic turbines installed or under construction are the three 35,000-hp. vertical-shaft Francis units being installed in the Big Creek No. 3 plant of the Southern California Edison Co. These units will operate under an 810-ft. head and run at 428 r.p.m. for 50 cycles and 514 for 60 cycles. This plant will ultimately have a capacity of 200,000 hp. Others are the two 40,000-hp. units for the Skagit Development of the City of Seattle, Wash., to operate under a 375-ft. head; three 22,700-hp. machines for the Dearborn and Mountain Island plants of the Southern Power Co. to operate under an 83-ft. head; four 22,000-hp. vertical-shaft reaction turbines for the Georgia Railway and Power Co., to be installed on the Tallulah and Tugaloo Rivers; four 25,000-hp. impulse waterwheels for the Hetch-Hetchy development of the City of San Francisco; two 40,000-hp. vertical-shaft reaction turbines to operate under a 421-ft. head in the Mt. Shasta development of the Pacific Gas & Electric Co.

Hydro-electric units under contract or in the process of construction in this country for the past 12 months amounted to over 2,000,000 hp. One company reports that at one time during the year it had under contract or in the process of erection a total of 750,000 hp. in hydraulic turbines, and new business for the year totaling over 430,000 hp. with approximately 400,000 hp. in the process of installation and about the same amount installed during the year.

Other plants under construction that involved special features are the Alcona development of the Consumers



ALLIS-CHALMERS 2,000-HP. PROPELLER-TYPE RUNNER FOR TURBINE TO OPERATE UNDER 4- TO 17-FT. HEAD

Power Co. on the Au Sable River, Michigan. In this plant both the power house and spillway are combined into one simple structure. There will be no spillway outside of the power house, all the waste water being discharged beneath the power house into the bottom of the draft tube. There are a number of advantages claimed for this scheme, among which are reduction in construction costs and an increased head.

The Mitchell development of the Alabama Power Co. is noteworthy on account of the power house being of the semi-outdoor construction, the building over the machines being of a character just sufficient to house

them. A second feature is that the flood water is discharged so as to suppress the back water in the tailrace, thus increasing the head on the turbines.

Automatic hydro-electric plants continue to find favor, and they are increasing rapidly. They are not only increasing in number but also in size, and last year a plant consisting of one 5,000-kva. unit was put in operation near Searsburg, Vt., by the New England Power Co. This is the largest single-unit full-automatic station in the world. The first automatic hydro-electric station was installed in 1917. Since that time they have been put into service in practically every state in this country, and at present an equipment is being designed for an installation of over 10,000 kilowatts.

Many Notable Electrical Developments During the Last Twelve Months

RADIO, high voltage, automatic control and increased size of electrical machinery with higher guaranteed efficiencies are identification marks that the electrical industry has left on the year 1922. The unprecedented interest in radio telephony that was one of the crowning achievements of 1921 has continued during the last twelve months, which has seen this method of transmitting messages adopted on large power systems. The possibilities of operating control apparatus by radio has received attention and methods of applying it suggested.

Experimentally, voltages as high as 1,500,000 have been used. Two manufacturing companies in this country have laboratory equipment installed for such voltages. A 1,000,000-volt testing equipment is being built for the California Institute of Technology, which comprises four 250-kva. 250,000-volt transformers. Purdue University has a 600,000-volt experimental transmission line. One electrical manufacturer reports the construction and shipping of two 500,000-volt transformers with two more under construction.

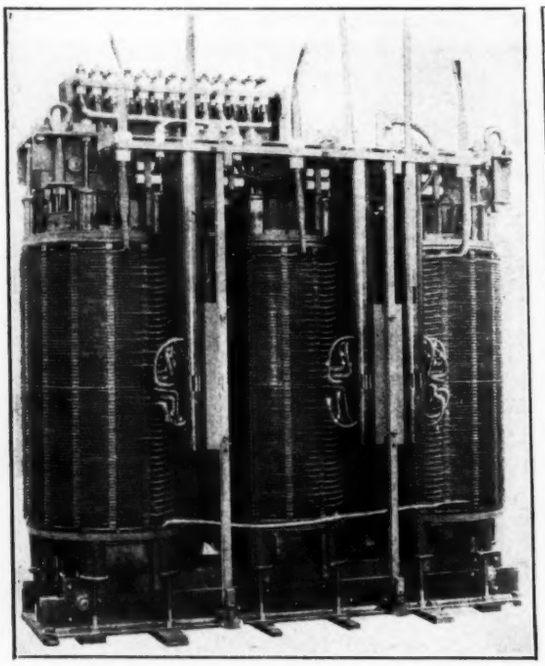
The size of turbo-alternators increased to 62,500-kva. Two of these machines are being constructed for the Brooklyn Edison Co., to be installed in its new Hudson Ave. power house. The largest turbo-alternators previously installed in the country are the two 45,000-kva. units of the Detroit Edison Co.

Recirculation of the cooling air through turbo-generators continued to make progress both in this country and in Europe. Several installations have been made which involve two different schemes. In one system the heated air from the alternator is cooled by passing through a water spray and returned to the machine. In the other arrangement the air is cooled by passing over water-cooled radiators. Provisions are also being made for introducing an inert gas into the machine as a fire extinguisher.

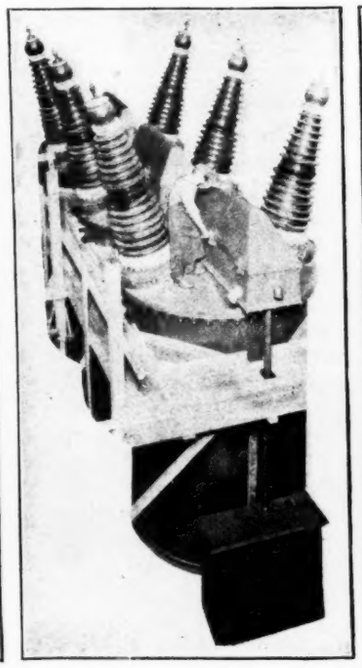
Increased use of electrically driven auxiliaries in large plants of recent design, is in evidence. This is particularly true of the Hell Gate Station of the United Electric Light & Power Co., New York, and the Calumet Station of the Commonwealth Edison Co., Chicago. The Cahokia Station now being built by the Union Electric Light & Power Co., St. Louis, has gone farther in this direction than any other, where the only steam-driven equipment is one boiler-feed pump and a duplex exciter used as a spare. Alternating current at 2,300 volts has become practically standard practice for motors of 50 hp. and larger.

There were several notable hydro-electric developments during the year as well as considerable expansion of existing plants. As a result a large number of machines of unusual size have been produced. At the close of the year one manufacturing company reports having waterwheel generators under construction aggregating 600,000-kva. capacity. This figure indicates the progress that is being made in water-power development.

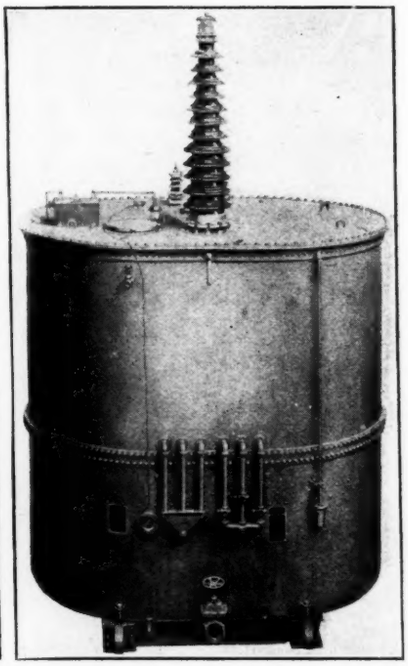
In hydro-electric plants the three 65,000-kva. units ordered by the Niagara Falls Power Co., represented



GENERAL ELECTRIC 12,000-KVA. 60-CYCLE 11,000- TO 2,300-VOLT SELF-COOLING TRANSFORMER

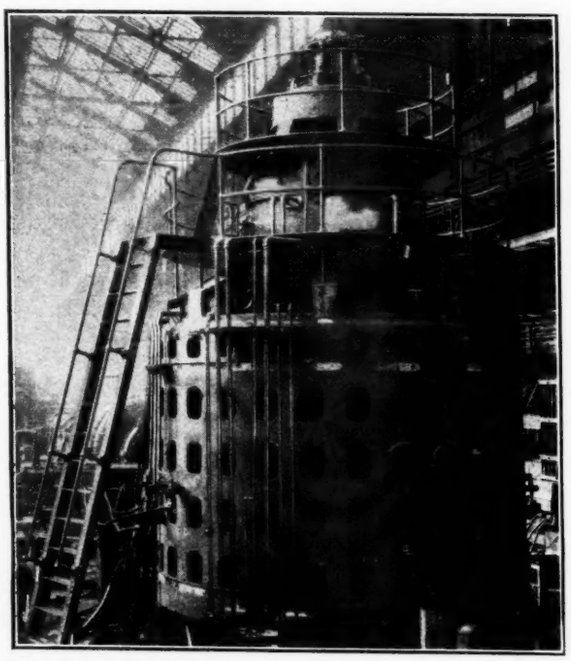


GENERAL ELECTRIC 220,000-VOLT OIL CIRCUIT BREAKER. NOTE MAN



WESTINGHOUSE 11,000- TO 220,000-VOLT 18,500-KVA. TRANSFORMER

an increase of 20,000 kva. in the size of this class of equipment. The largest machines previous to these are the five 45,000-kva. units installed in the Queenston plant of the Hydro-Electric Commission of Ontario. It is interesting to note that the new Niagara Falls



WESTINGHOUSE 28,000-KVA. VERTICAL WATER-WHEEL GENERATOR TO OPERATE AT 514 R.P.M.

Power Co.'s units are twice the capacity of the three 32,500 kva. units installed in 1919 and 1920, which were the largest machines of the kind then in existence. These large machines have the highest efficiencies ever given for waterwheel generators, at 65,000 kw. and unity power factor 98.1 per cent and at 0.90 power factor 97.8 per cent.

Another interesting development during the year is an unusual extension made by the Tallassee Power Co., to one of its plants. This consists of mounting a 31,250-kva. 60-cycle generator on top of an existing 18,000-kva. 36-cycle generator, which is provided with a hydraulic turbine of sufficient capacity to drive the larger machine. This special arrangement is due to commercial conditions and will permit the generation of 60-cycle energy during periods when the 36-cycle service is not required. It also makes it possible to use the unit as a frequency changer. Other large hydro-electric units have already been mentioned in the review of water power.

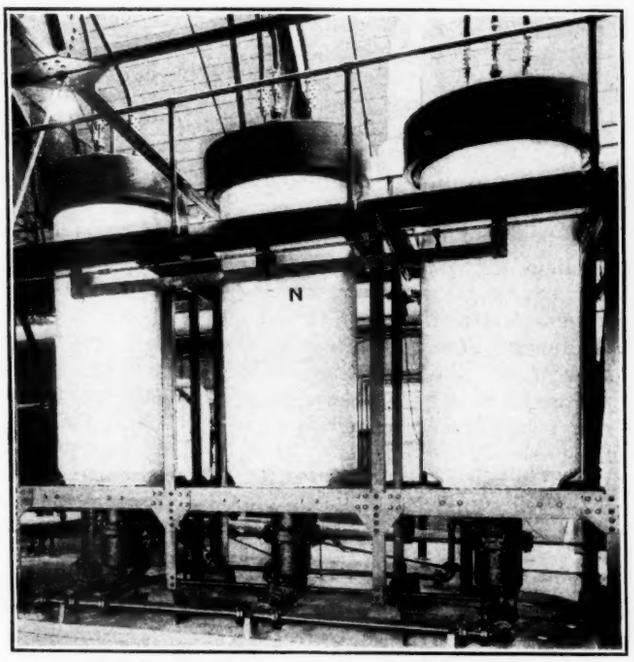
Among the large waterwheel generators under construction for foreign shipments are: Two 25,000-kva. for the Brazilian Hydro-Electric Co.; five 22,222-kva., three 18,000-kva. and three 14,444-kva. units for Japan; a 10,000-kva. unit for India; and two 15,000-kva. 50- or 60-cycle machines.

As sizes of generating units and power systems increase, transformers must also increase in capacity. In this respect the last year has seen notable progress. The activity in the construction of these large units is indicated by the fact that while in 1921 there were eleven 220,000-volt transformers aggregating 140,000-kva. capacity under construction, in 1922 there were 35 with a total capacity of about 400,000 kva. One company reports the construction of seven 18,500-kva. single-phase units for stepping up from 11,000 to 220,000 volts. The bank capacity of these transformers will be 55,000-kva. on 50 cycles and 58,000 kva. on 60 cycles, while another company reports the construction of seven 20,000-kva. single-phase units for 220,000 to 72,000 volts. These units are larger in their physical dimensions than any other previously constructed.

Other notable transformers are the six 36,700-kva. single-phase auto-transformer to tie together 150,000- and 220,000-volt systems. The bank capacity is 110,000 kva. These are physically the largest auto-transformers ever constructed, having a total weight with oil of 176,000 lb. per unit. Another company reports under construction or on order eighteen single-phase auto-transformers of 17,500-kva. each, to be used as a tie between 150,000- and 220,000-volt systems. An unusual feature of these units' operation is the fact that they are designed for connection into the line without high-tension switches or lightning arresters.

The general tendency toward the use of transformers of ever-increasing capacity is indicated by the fact that the average size of all units produced during 1922 was about 1,000 kva. greater than in 1921. Another indication of the growth in the average size of transformers is that during 1922 there were more units of 10,000-kva. capacity and larger, either completed or under construction, than the combined output in excess of 10,000-kva. for all previous years.

To meet the demands established by the large high-voltage large-capacity transformers, switching apparatus has kept step. The production of oil circuit



DOMINION ENGINEERING WORKS 25,000-KW. ELECTRIC STEAM GENERATOR

This generator consists of three single-phase units connected in star; neutral connection shown at *N*. On the steam end the three units connect to a common header without intervening valves.

breakers having a rated carrying capacity of 600 amperes at 220,000 volts and a rupturing capacity of 1,500,000 kva. is one of the most notable achievements of the past year and are the largest units so far built. Breakers are being designed for the Brooklyn Edison

Co.'s new plant that have a rupturing capacity of 1,400,000 kilovolt-amperes.

The electric steam generator came into more prominence during the past twelve months than ever before. At the end of the year over 200,000 kw. of this class of equipment was installed in this country and Canada. One company in Canada has manufactured over 116,000 kw. of this equipment. These include one unit of 12,000 kw., one of 15,000 kw. and two of 25,000 kw. capacity. The latter have absorbed as high as 35,000 kw. each. Each of the large steam generators consists of three single-phase units connected in star on a 6,600-volt three-phase circuit. On the steam end they connect into a common header without any intervening valves, the safety valves being on the header.

One electrical manufacturing company in this country has developed and placed on the market a new type of electrical steam generator, in which the shell is divided into an upper or steam producing section, and a lower or hotwell section, the water being kept in circulation between the two sections by a motor-driven pump. When the possibilities of the electric steam boiler are better understood, they undoubtedly will find a considerable application on hydro-electric developments.

Automatic station practice both in hydro-electric plants and in substations has made further technical and commercial gains, with a steady increase in unit capacities. It is no longer a question of operating the plant automatically, but of finding the economical dividing line between the automatically operated and the manually controlled station.

While the electric railways were the first to recognize the advantages gained under automatic control, other industries have rapidly followed their example with the result that this method has been applied to practically all phases of power generation and distribution. One electric manufacturing company reports that records to date show that it has over 650 automatic units installed controlling about 200,000 kw. of rotating electrical machinery.

A new and important departure in this field is that applied to central-station auxiliaries, where failure of one source of auxiliary power is made the means of automatic transfer to a second or even a third source.

Another new application is that to an alternating-current distribution system of the Kansas City Power & Light Co., where automatic control equipment operates substations having two or more 13,200-volt incoming feeders passing through transformer banks to 4,000-volt distribution lines. An automatic equipment for the control of 5,000-kva. synchronous condensers on the Penn. Public Service Co.'s systems at Madera, Pa., is the first of its kind and size. A group of four small automatic hydro-electric generating stations will be installed on an old barge canal at Connersville, Ind. In this case a manually controlled station will be supervised by the automatic stations. The first automatic direct-current waterwheel-driven generating station has been installed by the Ford Motor Co., Detroit, Mich. As indicated in another part of this review, a 60-cycle 2,300-volt 5,000-kva. full-automatic controlled waterwheel-driven unit is the largest of its kind yet installed. One manufacturing company has developed full-automatic-control equipment for 2,300-volt synchronous-motor 275-volt direct-current generator sets to the point where it has standardized them in sizes for 100, 150, 200 and 300 kw. capacities.

Synchronous motors continue to be given special attention by electrical manufacturers, and a number report improved types. One company reports the development of two lines of high-speed motors of this type for 100 per cent and 80 per cent power factors respectively. These lines include ratings from 50 to 2,000 hp. at speeds 327 to 1,800 r.p.m. Another company reports the development of a new form of synchronous motor for high starting duty. In this machine the stator is first brought up to synchronous speed without any reference to the load. When the stator is up to speed, the field excitation is gradually applied in the ordinary way and the rotor brought up to speed; in the meantime the stator is brought to rest. This type of motor can develop a starting torque of from 150 to 300 per cent of normal throughout the entire period of starting.

An interesting installation of slow-speed motors driving ammonia compressors consists of one 500-hp. 72-pole and two 500-hp. 90-pole machines. These machines are equipped with full automatic control. This has made possible the mounting of small master switches and meters convenient to the motor and the high-voltage switches in a separate room. The motors are started directly on high voltage.

Power-factor correction has been given special attention during the last year. A new type of static condenser has been developed in power sizes from power-factor correction which may be classed with transformers and motors as regards rugged construction. The power-factor characteristics of the synchronous motor are doing much to increase its popularity. and synchronous condensers are installed in many cases on central-station systems. Notable machines of this type are two 20,000-kva. units for the Pacific Gas & Electric Co. This class of equipment is finding much favor outside of this country. One company reports the construction of six 15,000-kva., three 17,000-kva., five 2,000-kva. synchronous condensers for export.

Another notable machine under construction is the 35,000-kva. frequency-changer set for the Gold Street Station of the Brooklyn Edison Company.

Oil Engines Meet with Increasing Favor

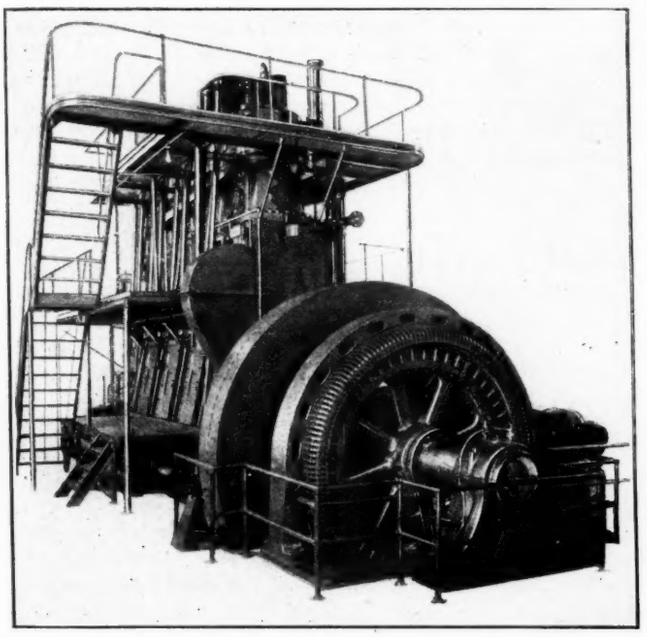
ANY discussion of the condition of the oil-engine industry must be divided into two portions, one dealing with the semi-Diesel and the other with the heavy-oil or Diesel engine. This is for the reason that the fields of usefulness of the two types of internal-combustion engines are quite dissimilar. The semi-Diesel engine is essentially one of small power and is especially suitable for what may be termed "occasional work," or for such installations where the use factor is low. Naturally, such operating conditions are found in small plants, such as flour mills, cotton gins, irrigation, etc. The year just closed has not been one of encouragement to the small industrial, and it is not surprising that the sale of semi-Diesels fell off from former years. To somewhat offset this, there has been an increase in the sale of these engines to plants formerly using central-station service. The coal clause embodied in many of the electric-power contracts has made the rate far above the contemplated one. As a result many plants having a load of 25 to 75 kw. have installed this type of oil engine.

Another field that has shown considerable activity is that of small shipping. There is a strong drift toward the semi-Diesel as auxiliary power for small sailing

vessels, such as fishing smacks, etc. On the Pacific Coast especially, hundreds of kerosene engines on small vessels have been replaced by this type of oil engine.

The Diesel engine builders as a whole have enjoyed a prosperous year. As in all past years the oil pipe-line companies have been the largest purchasers of Diesels. One pipe line closed contracts with three builders for a total of over 20,000 horsepower, to be installed on a pipe line from Oklahoma. In the course of two or three months there is every expectation that the engines for the pipe line connecting the government oil field in Wyoming with Kansas City will be purchased. At the present time one other oil company is preparing to close contracts for a considerable horsepower of Diesels.

The central stations have absorbed about 25 per cent of the Diesels manufactured each year in this country.



McINTOSH & SEYMORE 750-HP. DIESEL-ENGINE GENERATOR UNIT FOR THE KEY WEST ELECTRIC CO.

The same approximate ratio was maintained during the past year, and a number of central stations have turned to oil power. One of the most interesting of these installations is that of the Consumers Light & Power Co., New Orleans, which purchased four 750-hp. Diesel engine-generator units during 1922, two of which are at present in operation.

The illustration shows a 750-hp. unit installed at Key West, Fla., to care for the increased load of the Key West Electric Co. This plant has used Diesel engines for some twelve years and has been able to burn a heavy residuum of oil with success.

There has been a marked drift toward larger units. Only a few years ago the Diesel engine was confined to sizes under 500 hp. It was considered that 150 hp. per cylinder was the maximum to be obtained save at the sacrifice of reliability. This impression has been obliterated, and a number of manufacturers are building units of 300 to 400 hp. per cylinder. Two years ago an investigation by *Power* on the Diesel engine industry revealed that the average horsepower per engine was close to 300. During the last year the average horsepower per engine sold was over 500 and the total horsepower approximately 70,000. This is evidence of the greater faith of the builder as well as the increased confidence of the power user in the internal-combustion engine.

The sale of Diesels to textile and other industrials has not been as large as was to be expected. This may be traced to the attitude of many factories of withholding the purchase of new equipment even at the sacrifice of economy until business has become more adjusted.

The marine field proved, as unfortunately has been the case in most years, that it held more promises than realities for the Diesel engine builder. New investments are not being made in shipping, and the new year will see but little more activity even if a subsidy bill is passed by Congress. Even the action of the shipping board in offering to sell boats at a price such that the total cost of the vessel with Diesel drive would amount to less than $75 per ton dead weight, found but three or four acceptances.

A marked activity has been shown in the development of solid-ignition, gas-injection and other oil engines not using air compressors. These units have been of such sizes as to be competitors of the semi-Diesel rather than of the Diesel engine. It would seem that these types will find their logical place between the capacities that are naturally Diesel and those adaptable to the semi-Diesel.

The coming year, from present indications, should be a profitable one to the oil-engine builder. The cost of power is being examined more closely than ever before by the executive. The lower cost of operation of the oil engine compared to steam power or central-station service under the present high coal prices gives the former a marked advantage even in many plants where process steam is needed. In contradiction to the steady rise in coal prices during the last five years, fuel oil, while fluctuating in sympathy with supply and demand, is no higher now than in 1914 and the variation in quotations from day to day or year to year is but slight. The major portion of the oil-engine plants are in the Midwest and Southwest, where the prices of refined oils are lower that at Seaboard. With the development of the present-day Diesel to burn the heaviest of boiler oil, sales along the Atlantic seaboard, where Mexican boiler oil is very cheap, will no doubt show a marked increase.

Refrigeration

The most interesting development in the refrigeration field is the increased use of compound compression and in the drift toward central-station service for power.

While compounding is by no means new, the idea of making use of the standard compound air compressor for the compression of ammonia was tried out with caution for several years. Only recently have refrigeration engineers as a whole accepted the plan as an accomplished fact.

One of the largest units of this type is the 600-ton machine to be installed by the Quincy Market Cold Storage Co., Boston, ordered during the past year. This machine is a compound feather-valve air compressor direct-connected to a Worthington unaflow engine and is along the general lines of the unit described in *Power*, Dec. 19, 1922. There is every reason to believe that all future plants of over 200 tons will be compounded even though ice-machine builders are not in

entire agreement with this demand of refrigerating engineers.

Many ice plants, especially those in the larger cities, are more and more discarding the steam drive and are purchasing electric current. The high fuel prices have been the chief factors that influenced this change. The central-station rates for refrigerating plants are most favorable ones and do not as yet reflect the increased cost of electric power generation caused by the present high coal costs. Many stations offer rates well below one cent per kilowatt-hour, and this is quite under the cost of production of the isolated plant purchasing coal in the open market.

For the refrigerating plant developing in new power, the choice of prime mover seems to be poppet four-valve, unaflow and oil engines, the number of installations being in the order given. Since most of the important ice-machine builders are now developing unaflow engines, there is every reason to expect that the unaflow will soon be the leading prime mover for ice plants.

Legislation in the Power Field

NO LEGISLATION of any great importance in the steam or water-power fields has been passed. The legislative work of the American Uniform Boiler Law Society amounted to little, as there were only five states whose legislatures convened. In Georgia the Society's bill was introduced and then killed by its proponents because the opposition introduced an amendment unacceptable to them. A similar situation arose in Maryland. The complete list of states and cities that have adopted the A.S.M.E. Boiler Code is given by the Society as follows:

STATES

Rhode Island	Oklahoma	Utah	California	Arkansas
Minnesota	Indiana	Ohio	Delaware	Washington
Pennsylvania	Wisconsin	Missouri	Michigan	New Jersey
Maryland		New York		Oregon

CITIES

Detroit, Mich.	St. Joseph, Mo.	Seattle, Wash.
Erie, Pa.	Philadelphia, Pa.	Parkersburg, W. Va.
Kansas City, Mo.	Chicago, Ill.	Omaha, Neb.
St. Louis, Mo.	Memphis, Tenn.	Nashville, Tenn.
Allegheny County, Pa.		Scranton, Pa.

In April New York was added to the list of states that have agreed to accept boilers bearing the stamp of the National Board of Boiler and Pressure Vessels Inspectors on the same basis with boilers inspected by their own officials. Revisions in the state boiler rules will be made on the basis of the corresponding revisions made during the year in the A.S.M.E. Boiler Code. Committees have also been formed for the consideration of the locomotive and miniature boiler codes, with a view to their adoption by the state.

Important water-power measures passed by the New York State legislature included the Ferris amendment, limiting development of water power in forest-preserve lands to 3 per cent of the total and limiting water-power leases to terms of fifty years. The Robinson water-power law provided for the development of state-controlled water power by fifty-year lease to privately financed corporations, with regulation of service and charges by the Public Service Commission. The fate of these laws is now uncertain in view of the recent change from Republican to Democratic administration.

The constitutionality of the Federal water-power law has been questioned by New York State on the ground that the government's jurisdiction extends to the development only of those water powers where navigation rights are involved. This contention is the subject of an original bill filed against the Federal Power Commission, hearing of which will be held on Jan. 2, 1923.

Rules for the reciprocal registration of professional engineers, permitting an engineer registered in one state to practice in other states having license laws, were agreed upon in a conference of the State Boards of Engineering Examiners of the following states:

Arizona	Illinois	Minnesota	South Dakota
Colorado	Iowa	New Jersey	South Carolina
Florida	Louisiana	North Carolina	West Virginia
Indiana	Michigan	Oregon	Wyoming

Passed by the Senate in February, the Patent Office Relief Bill provided for a substantial increase in salary, particularly to the technical employees of the office; an increase in personnel and authority to raise patent fees sufficiently to cover the increased expenditures. Latest reports, however, indicate that in spite of this bill the Patent Office is still swamped with applications and that with the revival of industry the office is having difficulty in holding its experienced technical men as examiners against the inducements of private employment.

The Colorado River treaty, signed in November by Secretary Hoover and members of the Colorado River Commission, will become law when approved by the legislatures of each of the states involved, and by Congress. This treaty allows a total of 7,700,000 acre-feet of water a year to each of the two Colorado River basins, at the same time permitting lower basin to increase this amount by 1,000,000 acre-feet a year if necessary. Navigation is subordinated to all other uses of Colorado River waters, and power is subordinated to agricultural and domestic uses.

Engineering Societies Extend Their Activities

OF PRIME value among engineering society accomplishments was the report of the Committee on Work Periods of the F.A.E.S., on the two-shift versus three-shift working day. This committee found that the two-shift day of twelve hours per shift was not an economic necessity in any American industry, and recommended the universal adoption of the three-shift, eight-hour day. In this report the Federation gives evidence of its continued desire to work for the good of the profession as a whole, and further proof of this desire is found in the appointment by the F.A.E.S. of a committee of leading engineers to study and report upon every phase of the Muscle Shoals problem. Other questions of national engineering importance now being considered by the Federation are the registration of engineers, the question of international engineering federation, the establishment of a national hydraulic laboratory and co-operation in the movement to save the nation's forests. The executive board met in Chicago on March 10 and in Boston on Sept. 8, and its next meeting will be in Washington on Jan. 4, a week in advance of the annual meeting of the American Engineering Council.

The year has been marked by a strong tendency toward affiliation on the part of those engineering bodies in one locality having a number of objects in common. Among such affiliations are the Associated Technical Societies of Detroit and the Affiliated Technical Societies of Boston. Affiliation of the various engineering societies in Connecticut, proposed last spring, has not yet been consummated. At a meeting held in New Haven last March, sixteen societies voted

in favor of affiliation, but expressed the desire to make a thorough study of the details of the plan before committing themselves to its adoption.

In England there is found evidence of the affiliation movement, and of the movement toward international co-operation among engineers, in the formation of the Engineers' Joint Council, composed of the four leading engineering societies—the Institutions of Civil, Mechanical and Electrical Engineers, and the Institution of Naval Architects. One of the objects of this Engineering Council is similar to that which actuated the formation of the Federated American Engineering Societies, namely: "To insure better utilization of their services in the country's interests."

A further result of the affiliation idea is seen in the formation, at a recent meeting of the technical sections of the N.E.L.A. in Milwaukee, of a committee to co-ordinate power-plant investigation and research, composed of the chairmen of the A.I.E.E. electric machinery and power stations committee, N.E.L.A. prime movers and electrical apparatus committee, American Electric Railway Association committee on power generation, and the steam turbines and generators committee of the Association of Edison Illuminating Companies. The new co-ordinating committee was formed for the prevention of duplication of effort in the work of these committees.

The American Society of Mechanical Engineers approved for publication the revised Boiler Code, the Fuels Code, the codes for locomotives, gas producers and internal-combustion engines, and Chapters I, II and III of the Report of the Committee on Instruments and Apparatus. These will be issued in tentative printed form for comment and criticism. The test codes for reciprocating pumps and for feed-water heaters have been fully discussed and recommended to the Council for adoption. The Society showed a desire to broaden its field by holding a series of management meetings of local sections in all parts of the country, at which management problems were discussed with special reference to local conditions. Another good work undertaken by the A.S.M.E. was the establishment of a national museum of engineering at the Smithsonian Institution in Washington, for the purpose of bringing to public attention the work of the engineer. The A.S.M.E. was the first of the large national societies to adopt the code of ethics drawn up by a committee of leading society members, headed by Prof. A. G. Christie, of Johns Hopkins University. The code commends loyalty to country, personal honor, fairness to contractors and workers and interest in public welfare.

Having for its object the study of the human factor in industry, a new organization known as the National Personnel Association has taken over the activities of the National Association of Corporation Training and the Industrial Relations Association of America. The new association, composed of leaders of organized engineering, representatives of large industries, insurance companies, railroads and publishers and members of University faculties, is aiding business executives in solving the problems of personnel administration.

The American Engineering Standards Committee has been active in considering and approving safety codes relating to mechanical and electrical engineering. Twenty-four standards have been approved and thirty-six are now up for approval. Those under consideration include a code for conveyors and conveying machinery, the heating and ventilating code of the American Society of Heating and Ventilating Engineers, and codes for mechanical refrigeration, power transmission apparatus, electric power control and compressed air machinery, pipe flanges and fittings, shafting and ball bearings and a code for the rating of electrical machinery.

The Honor Roll for 1922

IN CONCLUDING the review, mention must be made of those honored for exceptional service in engineering and allied fields. The Edison Medal for 1922 was awarded Dr. Robert A. Millikan, of California Institute of Technology, while Senator Guglielmo Marconi, of Italy, was the recipient of the John Fritz medal, in recognition of his discovery of wireless. Col. Arthur S. Dwight, president of the A.I.M.E., and Charles F. Rand, chairman of the Engineering Foundation, were decorated by the French government with the Chevalier Cross of the Legion of Honor. In addition, Colonel Dwight was elected to honorary membership in the Chemical, Metallurgical and Mining Society of South Africa, while Mr. Rand was elected to honorary membership in the Association of Members of American Engineering Societies in Cuba. Dr. A. E. Kennelly, of Harvard, also received the cross of the Legion of Honor, for distinguished service as exchange professor in engineering to the French Republic.

Thomas A. Edison was tendered a testimonial dinner to commemorate the fortieth anniversary of the central-station industry and the part taken in this industry by the great inventor. E. W. Rice, Jr., formerly president of the General Electric Co., was elected an honorary member of Tau Beta Pi, a national honorary engineering society. Prof. Edward F. Miller, head of mechanical engineering at Massachusetts Institute of Technology, was made an ordnance colonel in recognition of his war work for the government. For a paper on "Steam Formulas," Prof. Robert C. H. Heck, of Rutgers College, was awarded a life membership in the A.S.M.E. Life membership in this society also was awarded to Fred J. Miller, in honor of his thirty-two years of service and especially of his recent voluntary work as acting secretary of the society, while Calvin W. Rice was in South America representing the American engineering societies at the International Engineering Congress at Rio de Janeiro, Brazil.

The honor of leadership in the societies and associations closely allied to *Power's* field has been conferred as follows:

Society	President
American Engineering Council of F.A.E.S.	Mortimer E. Cooley
American Society of Mechanical Engineers	John L. Harrington
American Institute of Electrical Engineers	Frank E. Jewett
Association of Iron and Steel Electrical Engineers	R. B. Gerhardt
American Society of Refrigerating Engineers	W. S. Shipley
American Society of Heating and Ventilating Engineers	J. R. McColl
National Association of Practical Refrigerating Engineers	Harry T. White
National Electric Light Association	Frank W. Smith
National Association of Stationary Engineers	Fred Felderman
American Boiler Manufacturers' Association	A. G. Pratt
American Order of Steam Engineers	George T. Crum
National District Heating Association	E. L. Wilder
Stoker Manufacturers' Association	S. A. Armstrong

Another honor came to Benjamin G. Lamme, chief engineer of the Westinghouse company, in the form of the Joseph Sullivant Medal, awarded by the Ohio State University in recognition of Mr. Lamme's notable engineering achievements. In 1919 he was the recipient of the Edison medal.

Cahokia Station

Outstanding engineering features of the new Station of the Union Electric Light and Power Co. of St. Louis, Mo., this plant being a conspicious example of a large central station using pulverized coal as fuel.

FROM ARCHITECT'S DRAWING OF ULTIMATE STATION

EARLY in 1922 it became apparent that the demand for electric power in St. Louis and vicinity would soon be greater than the combined available capacities of the hydro-electric plants of the Mississippi River Power Company at Keokuk, Iowa, and of the Ashley Street steam plant of the Union Electric Light and Power Co. This resulted in general plans by the latter company for a 240,000-kw. plant, the first section to be built for 60,000 kw. General plans for the station have been completed by McClelland & Junkersfeld, Inc., the engineers and constructors, and construction work is under way. The first section of the plant is to be in operation by the early fall of this year.

The site chosen for the plant is on the Illinois side of the river, a few hundred feet south of the city limits of East St. Louis, between the government levee and the river, and consists of about fifty acres of low ground practically all of which is made of land, though at one time an arm of the Mississippi River ran diagonally across the property. The formation of this land necessitated the supporting of the entire plant on concrete piles incased in interlocking sheet-steel piling, it being necessary to provide for a difference of approximately 45 ft. between extreme high and extreme low water level. The first section of the station is supported on about 3,000 concrete piles, and the river wall is made of precast interlocking concrete and steel piles, each about 75 ft. in length and weighing approximately 15 tons. A view of this is shown in Fig. 1. The distance above grade to the brick and steel structure of the plant is some 40 feet. The foundations and river wall involved unusual problems due to the character of the soil and the river action.

Locating the plant on the Illinois side of the river gave it excellent railroad facilities and accessibility to the center of coal supply, obviated bridge charges, and made possible a saving of 29 cents per ton on the coal. It is also reasonably near the center of load demands.

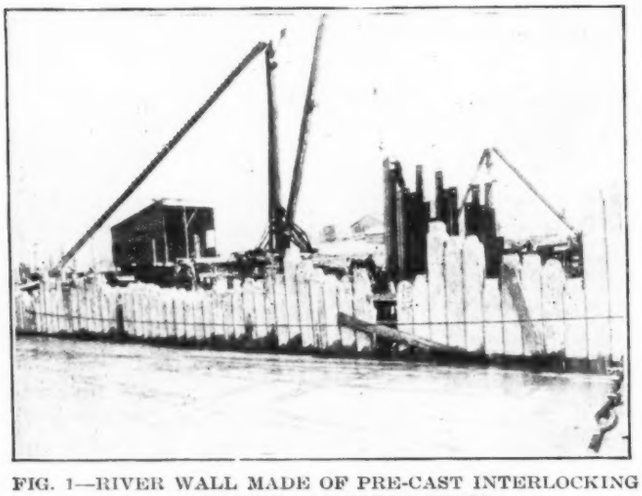


FIG. 1—RIVER WALL MADE OF PRE-CAST INTERLOCKING CONCRETE AND STEEL PILES

The plant will be built in four complete and independent sections. This requires a minimum of immediate investment and permits taking advantage of changes in the art. It has been designed for 0.65 sq.ft. of ground area and approximately 56 cu.ft. of space for each kilowatt of capacity. The 60,000-kw. section now being constructed is one-quarter of the ultimate 240,000 kw. capacity of the station. Certain features of the construction are shown in the exterior view of the ultimate 240,000-kw. section and in the general plan and cross-section of the initial installation. The present section is self-contained, with the exception of the rotary car dumper and carries no advance investments for future units, and keeps the fixed charges at a minimum.

This is the second large central station to adopt pulverized coal as fuel, and while the factors that influenced the decision in this case are not necessarily applicable to other large plants, the quality and price of the coal and the site of plant were the major ones. A further advantage of this system was seen in its ability to utilize sweepings and other types of waste fuel in the event of strikes affecting the regular supply. The coal that will be used is of low heating value and contains in the neighborhood of 17 per cent ash.

The magnitude of the ultimate station and the quality of the coal as a factor in committing this station to burning coal in the pulverized form were arrived at after exhaustive tests on various types of equipment by the engineers and have brought out various features in design and advancement of the art. Chief among these is the location of the preparation plant, which is contained in the boiler-room structure, thus utilizing space that has not been allotted to equipment in other stations, and is contrary to the usual practice of installing the pulverized plant in a separate building. At the same time it is isolated from the remainder of the boiler room by a solid brick and concrete wall and is further segregated into three distinct rooms, two of which contain four pulverizing mills with a capacity of five to six tons per hour and the third contains two mills of the same type and size.

The pulverizing plant, with eight mills operating sixteen hours a day, will pulverize sufficient fuel for a twenty-four-hour full rated output of the main units.

Coal as received from the mines will be weighed on track scales and then handled by a rotary car dumper or dumped directly into a hopper beneath the tracks, and then through a crusher and a Bradford breaker of sufficient capacity for one-half the ultimate station. A series of belt conveyors and bucket elevators deliver the green coal to a bin above the pulverizing room. Moisture is removed from the coal in driers which utilize the heat from the boiler exit gases, which are drawn through the driers by induced-draft fans. From the driers the coal is spouted directly to the mills. It is then transported in pulverized form by compressed air through a series of weighing tanks and collectors to pulverized-coal bins of 75 tons' capacity each, located in the center aisle directly above the burners.

The initial boiler installation will consist of eight of the cross-drum type, each of 18,010 sq.ft. heating surface, arranged in two rows with a central firing aisle. The boilers are designed for 350 lb. pressure, but will operate at approximately 300 lb. at the turbine and a total temperature of 690 deg. F. Each boiler will have ten burners located in the top of the furnace, as shown in the section, Fig. 2. The control for each four boilers will be placed close to the individual boilers of the group and will be under the control of a boiler watch engineer.

The furnaces are designed with ample volume and capacity for burning low-grade coal with a long flame characteristic. Additional square feet of heating surface is obtained with the water screen in the lower part of the furnace. An unusual design has been developed in connecting this with the circulating system.

The hopper bottom of the furnace serves as an ash-pit. Hand-operated gates and sluicing are employed in ash handling. The ashes will be utilized for filling in and building up the land surrounding the plant.

One stack with outside breechings is provided for each four boilers. Their construction of superimposed reinforced tile concrete is an unusual feature.

At the present price of coal, economizers will not be installed. However, provision is made above the boilers for them, and for induced-draft fans if at any future time the price of coal and operating conditions should warrant their installation.

The turbine room of the present section under construction has been laid out to accommodate two 30,000-kw. units, one single-cylinder General Electric and one single-cylinder semi-double flow Westinghouse placed parallel to the building. Each unit will be arranged for bleeding steam for feed-water heating, and in addition the exhaust from a house turbine will, when desired, be used for adjusting the heat balance of the station. Surface condensers of 53,000 sq.ft. each are located, due to the wide variation in the river-water level, in a single oval-shaped condenser well, the floor of which is approximately 42 ft. below the operating platform.

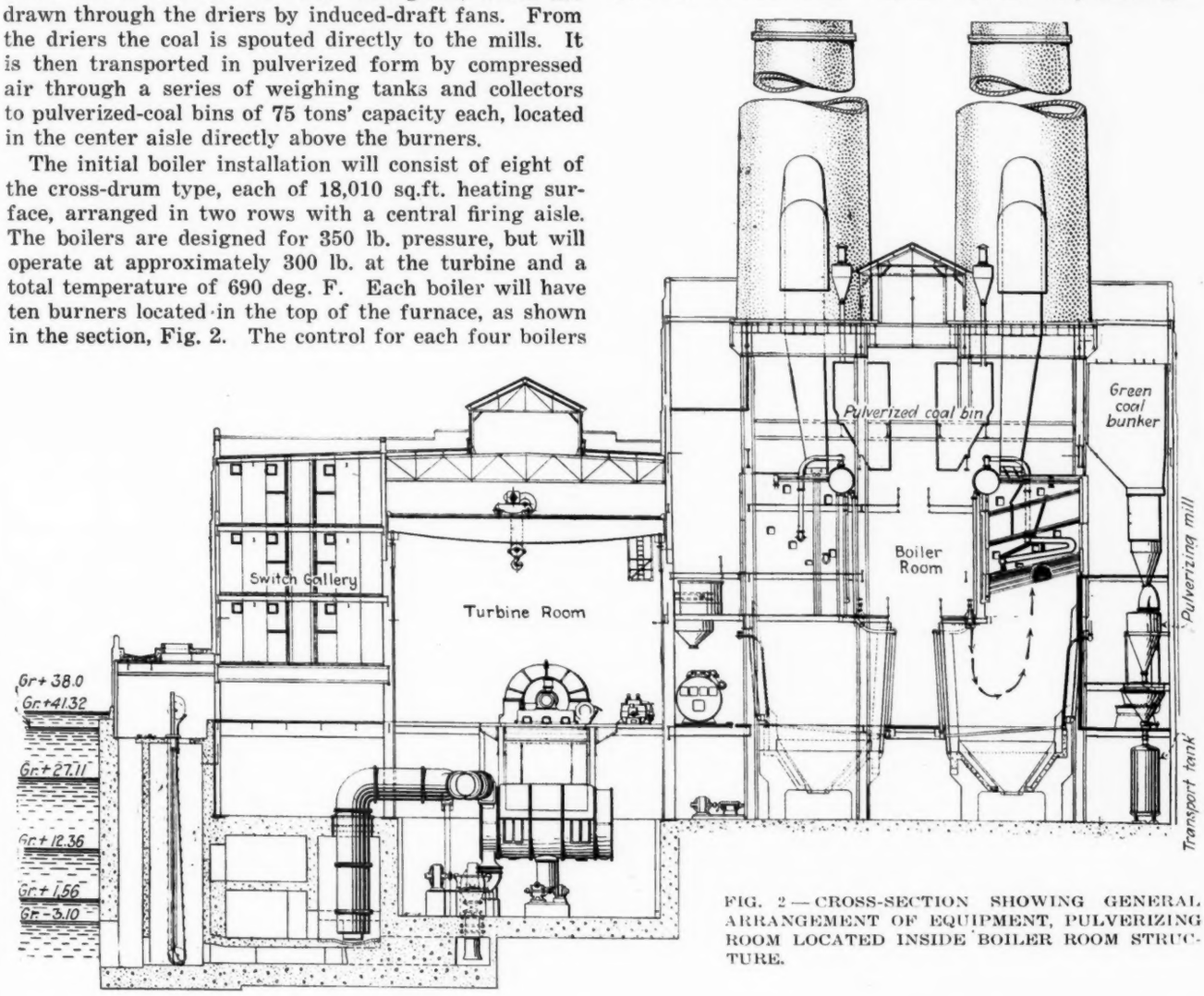


FIG. 2 — CROSS-SECTION SHOWING GENERAL ARRANGEMENT OF EQUIPMENT, PULVERIZING ROOM LOCATED INSIDE BOILER ROOM STRUCTURE.

Each condenser has two circulating, two hotwell and one rotary dry vacuum pump.

Electrically driven auxiliaries will be used throughout with the exception of one feed pump and one duplex exciter.

The circulating water system is laid out with twin intakes and a common discharge, and both traveling and stationary screens will be used. The intake tunnels are very short and do not project outside the build-

ing. This was made possible by placing the river wall of the station on the inner harbor line. The tunnels are also divided so that when one unit is operating, the circulating-water discharge may be used to flush out the other intake.

The two main units in the initial installation will generate three-phase 60-cycle current at 13,800 volts and will have direct-connected exciters; a stand-by exciter of suitable capacity for both units will be steam and motor driven. For air cooling the generator, the close ventilating system will be employed.

The main switchhouse, which is in the west wing of the plant adjacent to the turbine room, is divided into two sections with a repair room between them. Each section contains the complete switching and control equipment for one unit. A main and auxiliary bus will be used on the low tension and a ring bus on the high tension.

The high-tension buses and circuit breakers will be vertically isolated by employing a separate floor for each phase. The main and reserve buses of the same phase will be located on the same floors, but in separate rooms and separated by an operating aisle.

The disconnect switches will be remote control, manually operated and will be interlocked mechanically with the oil circuit breaker. An outdoor substation and a transmission voltage of 66,000 may ultimately be used.

The heat-balance control room is on a level with the main turbine-room floor. From this point all the motor-driven auxiliaries can be stopped but not started. Directly above this room are the main generator and feeder controls. Practically all the auxiliary motors will be alternating current and will operate at constant speed, except the fuel feeders, and these will be driven by direct-current motors. The station will be connected through three direct tie-lines to the Ashley Street steam plant. Current will be transmitted at 13,800 and 33,000 volts through step-up transformers to new and existing substations and will leave the station in underground ducts or submarine cables.

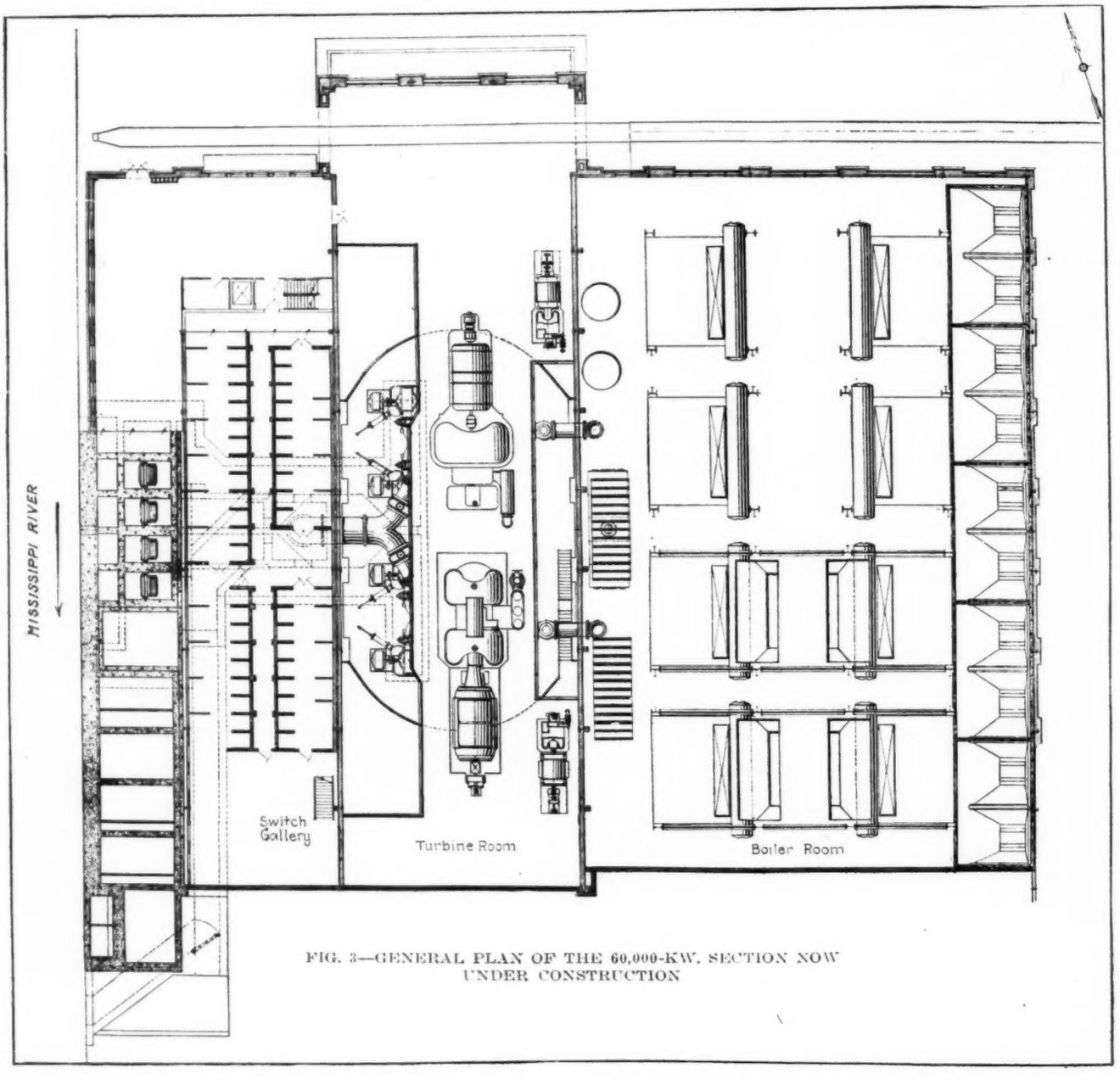


FIG. 3—GENERAL PLAN OF THE 60,000-KW. SECTION NOW UNDER CONSTRUCTION

How the Navy Handles the Feed-Water Problem

The series of articles on feed-water treatment which ended with a general review in the last issue, was designed to cover stationary practice. Conditions on sea differ in many ways from those on land. Hence there has grown up a special marine technique of feed-water treatment. This is particularly true in the navy, where the existence of centralized authority and of a few well-standardized types of plants has led to the preparation of a definite code for feed-water treatment. This code, which was prepared by the Navy Department's Bureau of Engineering under the direction of Admiral Robison, has been issued by the department as part of the "Manual of Engineering Instructions" and also as a separate booklet entitled "Instructions for the Care and Test of Boiler Feed Water and for the Operation, Care and Repair of Feed-Water Apparatus." The following abstract covers those portions of the booklet that are of greatest interest to stationary engineers.

Distilled Sea Water Preferred

The water used for boiler feed should be as follows, in order of desirability: (1) Water distilled from sea water; (2) water brought aboard from ashore and then distilled in the ship's evaporators; (3) undistilled water from ashore. The preference for distilled sea water over distilled water from ashore is due to the fact that the ship must always use distilled sea water when at sea and would therefore have its routine disturbed by changing over to distilled land water at times when the ship is in port.

The high concentration of solids in sea water requires certain precautions in connection with evaporator operation that would not be necessary in the case of plants using the natural waters found ashore. The chief danger is that the evaporators may be forced to a point where some of the dissolved impurities, chiefly common salt, are carried over into the distilled water by an action corresponding to priming in a boiler. It is required that the chlorine in the distilled water be kept at all times below one-half grain per gallon. This chlorine, as determined by a silver-nitrate test, is in direct proportion to the amount of salt carried over. All parts of the piping system must be so laid out and maintained as to prevent the contamination of the feed water by sea water. The amount of makeup must be kept to a minimum by keeping boilers, piping, glands, valves, etc., tight and in good working condition.

Much Attention Paid to Corrosion Prevention

Corrosion is to be reduced by keeping the boiler water slightly alkaline at all times. The greatest care is to be taken to keep air from getting into the feed system. This should be done not only to prevent corrosion, but also to avoid loss of vacuum due to an excess of air carried into the condenser. Air may get in through glands connected to the low-pressure cylinders and at other points where the pressure is less than atmospheric, so particular care should always be taken to prevent such leakage.

To prevent any air contained in the feed water from entering into actual circulation in the boiler, the entering feed water should be forced toward the steam space. This may be accomplished by extending the internal feed pipe the entire length of the boiler drum and arranging the holes so that the feed water is discharged upward toward the steam space. The feed pipe should be placed in the lower part of the drum with the holes at least six inches below normal water level. So far as possible air should be removed by heating the feed water, using (where feasible) a vacuum on the heater to effect more complete deaëration.

Any leakage of sea water into this system immediately results in serious trouble in the form of corrosion, scale and foaming. To detect such leakage, the condensate is tested for chlorine every hour while at anchor and every fifteen minutes while under way. In making this test, due consideration is given to the fact that a given amount of leakage will show the highest percentage of chlorine in the condensate when the load is lowest. In the boilers themselves the upper allowable limits for chlorine are 30 grains per gallon in small water-tube boilers, 50 grains in large water-tube boilers and 100 grains in fire-tube boilers. [The reader should not assume that these figures are directly applicable to land boilers. The chlorine in sea water, bearing a practically constant relation to the other impurities, may be used as the measure of the latter on a fixed basis. On land, however, no two plants would be the same in this respect.—Editor.]

The vapor from the evaporator should go to the distilling condenser and then to measuring tanks rather than directly into the exhaust-steam pipe or the main condensers. This permits the testing of each batch for chlorine before it is sent to the feed tank. Any direct connections between salt-water and fresh-water piping should be blanked off.

Precautions to Keep Out Oil and Grease

To eliminate so far as possible trouble due to oil and grease in the feed water, no vegetable or animal oil shall be used for the interior lubrication of steam cylinders and valve seats. So far as possible, all artificial lubrication shall be dispensed with in such places. Grease or oil shall not be used to make gaskets or packing tight, and graphite shall be used only sparingly for this purpose. The maximum use shall be made of filters and grease extractors. Drains from fuel-oil heaters, coils in lubricating-oil tanks, etc., shall always, if possible, be passed through an inspection tank. When the gage glasses show that grease has entered the boiler, it must be removed by a surface blow.

The following water tests are made as a matter of regular routine:

TABLE OF TESTS

A. Every fifteen minutes—when under way—Test condensate from each condenser in use for salinity.
B. Hourly—at anchor—Test condensate from each condenser in use for salinity.
C. Daily—Test water in all steam boilers, main feed and filter tanks, and in reserve bottom for alkalinity and salinity.
D. Weekly—Test water in all idle boilers for alkalinity and salinity, and make corrosion tests on steel suspended in water.

The tests for salinity are simply chlorine determinations made with silver nitrate, while those for alkalinity are made in the usual manner with a standard acid solution and methyl-orange indicator. The navy-standard water-testing apparatus is used for these tests.

An electrical concentration indicator is now being installed on vessels of the United States Navy. This permits of the rapid and automatic determination of the chlorine content of condensate and boiler water.

The navy boiler compound should be used in just sufficient quantity to keep the alkaline strength of the boiler water at all times between $\frac{1}{10}$ and $\frac{1}{2}$ per cent. This is done to reduce corrosion to a minimum.

Why Motor Frames Are Grounded

Grounding a Safeguard Against Shock—Grounded and Ungrounded Frames Compared—Protection in Case of Transformer Breakdown—Effect of Grounding on the Fire Hazard

By EDGAR P. SLACK
Assistant Engineer, Underwriters Laboratories

IT MIGHT be inferred from the fact that the requirements for the grounding of motor frames form part of the National Electrical Code, that the object of grounding is to reduce the fire hazard. As a matter of fact the Code in many places recognizes the life hazard as well; and the principal purpose of the grounding rules is to provide safety to persons. There are

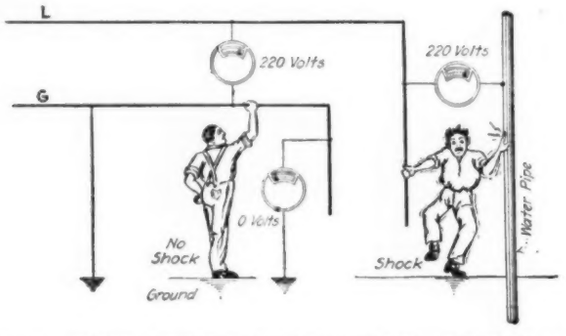


FIG. 1—SHOWS EFFECTS OF GROUNDING ONE SIDE OF AN ELECTRIC CIRCUIT

numerous advantages and also some disadvantages to grounding, which will be briefly discussed in this article.

Motor frames and electric conduits are grounded so that if they should become alive through failure of the insulation a person touching the frame or conduit while also in contact with a grounded object will be protected against receiving a severe shock. The conditions are so similar for the motor frames and conduits that only the former will be considered in detail.

First, take the simple case of a 220-volt circuit with a live line *L* and a grounded line *G*, as shown in Fig. 1. The grounded line *G* is at the same potential as the ground, being connected directly to it. A voltmeter connected between this line and ground would read zero, and a person touching the ground and this line at the same time would not be subjected to any difference of potential and therefore would not receive a shock. The live line *L* is at a potential difference of 220 volts from *G* and therefore also from ground, and a voltmeter connected from the line *L* to ground would register 220 volts. A person touching the ground and coming in contact with the line *L* would be touching two points of different potential and would therefore receive a shock.

Now take the case of a motor operating on this supply circuit, and having its frame ungrounded, as in Fig. 2. In the event of a breakdown of the insulation at *X* the frame becomes connected direct to the live line *L* and remains indefinitely at a potential of 220 volts from the ground. A voltmeter would show this potential difference, and a person touching the motor frame and making contact with any grounded object, such as a water-pipe, at the same time would receive a 220-volt shock.

To prevent such shocks, the motor frame is grounded as in Fig. 3. Now if a ground comes on the motor frame at *X* as before, it causes a short-circuit and blows the fuse *B*, clearing the motor entirely from the live line and making it impossible to obtain a shock from the frame. If the fault at *X*, instead of being a dead ground, were a leak of comparatively high resistance the current flowing from the live line *L* through the fault to ground might be insufficient to blow the fuse *B*, in which case the motor would remain connected to both lines. Even in this case, if the motor frame were properly grounded, it would remain at approximately the same potential as the ground, being in direct electrical connection with it, and so a person touching the frame and making contact with a grounded object at the same time would receive only a slight shock at most. The exact degree of protection against shock in this case depends on the resistance of the ground wire and connections, thus illustrating the need for a well-made low-resistance ground for the motor frame. The effect of resistance in the ground circuit will be discussed more fully later.

The grounding of the motor frame protects against shock not only from the low-potential motor circuit, but also from high-potential lines that the motor circuit might become crossed with. This protection is especially valuable for motors operated from transformers

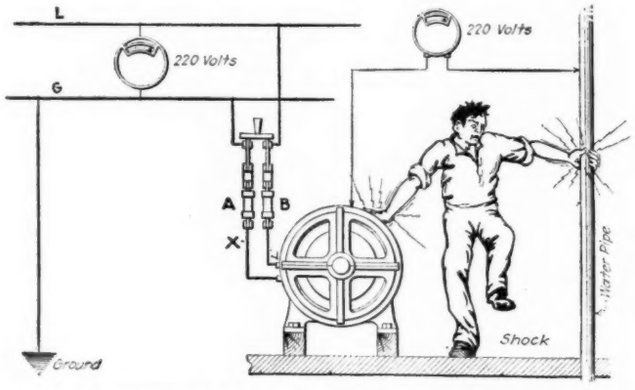


FIG. 2—WHEN FRAME OF MOTOR IS NOT GROUNDED, THERE IS DANGER OF OBTAINING A SHOCK AT FULL-LINE VOLTAGE

connected to high-voltage lines, on account of the possibility of accidental transformer breakdowns. Suppose, for instance, that a 220-volt motor circuit is supplied by a transformer operating on a 2,200-volt primary line, and that a breakdown occurs between the primary and secondary windings of the transformer, thus forming a direct connection between the 220-volt motor circuit and the 2,200-volt primary circuit. Even with the secondary circuit properly grounded, there is now the possibility that during the instantaneous rush of current through the low-voltage circuit to ground the

insulation of the motor might be punctured, making the frame alive. The motor frame, if ungrounded, would then present a serious shock hazard, but if it were grounded a severe shock would be unlikely for the reasons previously outlined.

It may be noted in passing that for the man working on the motor the ungrounded frame may be safer in many cases than the grounded frame, so far as receiving a shock from the motor circuit is concerned. If the motor is operating on a grounded circuit, as is generally the case, and the operator is adjusting the brushes or otherwise touching any live parts of the

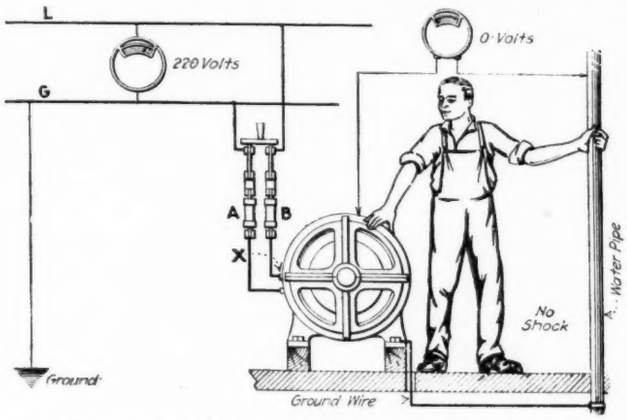


FIG. 3—GROUNDING FRAME OF MOTOR REMOVES DANGER OF BEING SHOCKED

motor and at the same time makes contact with the machine frame, then if the frame is insulated he will not receive a shock, but he may if the frame is grounded.

In spite of instances like this there is no doubt that grounding motor frames under the conditions specified in the Code results in a large increase in safety to persons. The effect on the fire hazard is more problematical, and it is probably true that the net effect of grounding motor frames is to increase the fire hazard. With the frame ungrounded as in Fig. 2, a single ground at *X* does not cause a flow of current. In order to produce a short-circuit, it would be necessary to have a second ground occur before the first one was cleared, a condition that can be avoided by systematic testing and proper maintenance. In the case of a grounded frame, however, as shown in Fig. 3, a single ground at *X* forms practically a dead short-circuit, and may cause a fire. This comparison shows one reason why the grounded frame is considered inferior to the insulated frame from a fire-hazard viewpoint and emphasizes the fact that the principal reason for grounding the frame is to afford safety to persons.

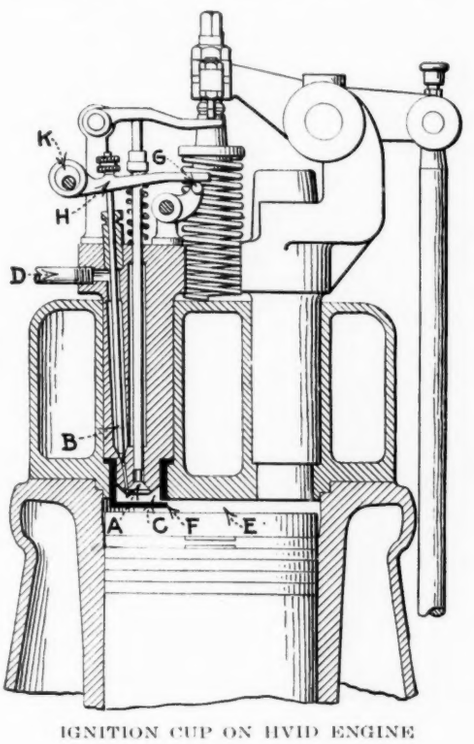
Balancing the Cylinders of the Hvid Oil Engine

BY L. H. MORRISON

The Brons oil engine, or as it is erroneously termed in this country, the Hvid engine, makes use of a cup *C* in the cylinder head, into which the oil charge is deposited by flowing along the governor-controlled needle valve *B*. The cup has one or two passages *F* leading into the combustion space *E* in the cylinder cavity. The compression of the cylinder air charge forces some of the air into the cup through these openings. The compression, ranging from 450 to 500 lb. per sq.in., raises the temperature to a high value. The air entering the cup passages picks up a small amount of oil vapor, and when the compression temperature is high enough the mixture of air and oil vapor in the cup ignites. A cup pressure much higher than the compression pressure exists in the cylinder results. The oil is ejected through the openings *F* into the cylinder by this pressure difference. The primary ignition in the cup then acts as the injection means in place of high-pressure air in the Diesel.

It has been the general experience that there is no great difficulty in building and in operating a single-cylinder Hvid engine. In larger powers, where more than one cylinder is required, many have found that the engine behaves at times in a most unsatisfactory manner, either running at an irregular speed or at a greatly reduced capacity.

The engine trouble may be traced to one or two faults. In the first place the size of the passages through the cup largely determines the length of the combustion period. If they are not the same in each cup, the rate of injection will not be the same for the two cylinders. The combustion will not be uniform and the speed may vary. In a single-cylinder engine, if the passage is too large, the engine behavior will allow the trouble to be detected and remedied by peening the holes to a smaller diameter, or enlarged if the combustion proves to be so delayed as to cause the exhaust temperature to be excessively high. In case of multi-cylinder units the trouble is not so easily detected.



IGNITION CUP ON HVID ENGINE

The chief operating trouble is caused by carbonization of the cup. In the single-cylinder engine this is detected at once by the loss of power. In case of a two- or three-cylinder unit the detection is difficult by reason of a certain characteristic possessed by this type of engine. The engine will develop an extraordinary power from a given cylinder size. If the load is heavy, the engine will hang on much like a steam engine, giving an increased torque even though the speed drops.

If the cup of one cylinder carbonizes, the other cylinders will carry the load at reduced efficiency and with a rapid carbonizing of the cups of these cylinders. One cylinder may be put entirely out of commission before the engine shows by its behavior that anything is wrong.

By drilling inspection holes in the exhaust elbow at each cylinder, the operator may detect at once, both by the sound and by the smoke of the exhaust, if one cylinder begins to lag. As soon as this occurs, the engineer should cut off the fuel supply to the cylinder in question, easing up on the load if necessary. The repeated compressions and re-expansions of the air drawn into the cylinder cause carbon in the cup to combine with the oxygen and burn. Usually, twenty to twenty-five compressions will completely clear the cup and the cylinder may then be put back into service. With this arrangement the multi-cylinder Hvid engine will function as positively and reliably as any other type of oil engine.

A Quick and Accurate Way To Align a Steam Engine

BY G. GROW

How many engineers are called upon to erect a steam engine, but from lack of familiarity with the best methods, find that what should be an easy task proves to be most difficult.

Each engine builder provides some means of locating the shaft and cylinder center lines. They may be indicated by marks cut into the upper surface of the engine sub-base or merely by measurements shown on the blueprint. If marks are placed on the base, there is no trouble is locating the sub-base on the foundation. Consequently, it will be assumed that there is no identification mark other than the measurements on the blueprint. The engineer should then ascertain the location of the two center lines from the drawing and mark the sub-base to correspond. The sub-base should then be

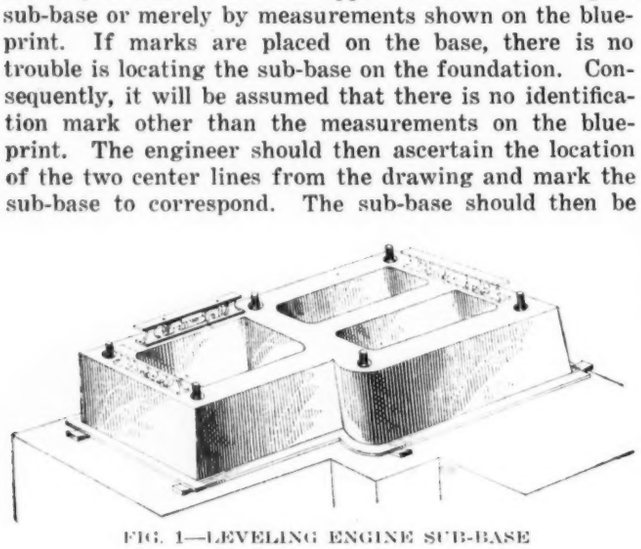


FIG. 1—LEVELING ENGINE SUB-BASE

moved over the foundation bolts and lowered onto foundation. Iron wedges, say 5 in. by 2 in. wide by 1 inch thick, should be inserted between the sub-base and the foundation. The wires showing the correct location of the shaft and cylinder center line, it is assumed, were erected when the templet was placed over the foundation excavation, prior to pouring the concrete. These lines should be restrung and the sub-base shifted to bring it in its correct position if the engine is to be belted to a lineshaft or machine. In direct connected engines the foundation bolts will locate the unit close enough, for as long as the unit is self contained its location need not be exact.

The next step is to level the sub-base. This is done by placing a spirit level crosswise and lengthwise on the top, as shown in Fig. 1. By driving in the wedges at the low points, the casting may be accurately leveled.

With the sub-base leveled, the engineer should proceed to grout it to the foundation. The nuts should be run down on the foundation bolts, but drawn up only lightly. A dam of clay is built around the top of the foundation at a distance of about three inches from the

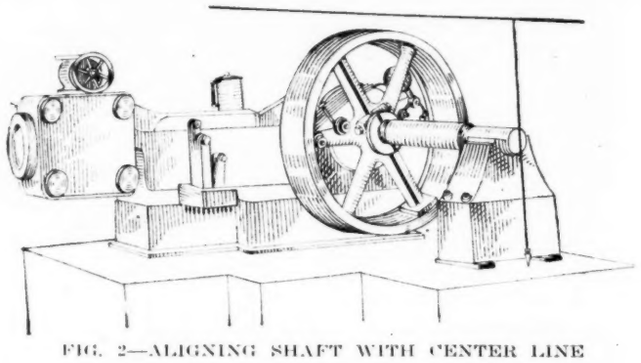


FIG. 2—ALIGNING SHAFT WITH CENTER LINE

lip of the casting. A mixture of equal parts of cement and sand worked up with enough water to make it free-running is then poured in between the clay dam and sub-base. By using a thin stick or piece of barrel-hoop steel, the grouting may be worked under the sub-base at all points.

After the grouting is hardened, say in twelve to twenty-four hours, the nuts should be drawn down on the bolts as tightly as possible.

The sub-base should be tested again by the spirit level, and if out of level the nuts should be loosened, the low side brought up by the wedges and then thin cement grouting poured in from the top of the sub-base.

Many erectors fill the hollow sub-base with cinders until it is about two-thirds filled, ram the cinders down and cover with about two inches of cement grouting of 1 to 3 mixture. The sub-base is made more solid by this arrangement. At the same time, if the engine is ever moved the light cement coating and the cinders may be removed much easier than would be the case if the base had been filled with concrete, although the latter is advocated by many experienced engineers.

With the sub-base in place the engine bed is moved onto it. In all high-grade engines the bed and sub-base are provided with dowels so that, with the sub-base aligned, the base is brought into the correct position at once. If for any reason the engine is not doweled, the base may be located close enough by setting it to bring the bolt holes in the bed in alignment with the foundation bolts. If refinement is desired, and this is essential where the engine is belt-driven, it is necessary, in the absence of dowels or other identifying marks, to place the engine in its approximate position as indicated by the foundation bolt holes. If, after the crankshaft is set into place, it is found to be out of alignment with the wire center line, the frame may be shifted to bring it into its correct position.

In aligning the crankshaft, most engineers run a wire through the main and outboard bearing, but this is necessary only on engines above, say 300 hp. The best method is to place the outboard bearing in its approximate correct position and then to place the crankshaft in place. Before lifting the shaft, the bearings as well as the journals should be thoroughly cleaned. The

quarter or side boxes and the wedges should be removed. The shaft is lifted and set in the bearings, being supported by the lower or bottom part of the bearing boxes.

The outboard bearing is then raised by wedges or adjusting screws until the shaft clears the flywheel side edge of the main bearing, being supported by the crank side of the main bearing and by the outboard bearing. A

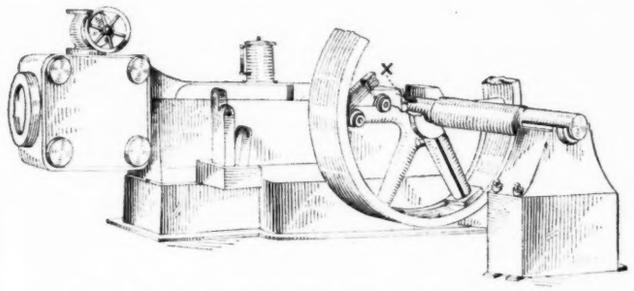


FIG. 3—QUICK WAY TO LEVEL CRANK SHAFT

light coating of red lead is placed on the main bearing at *X* and the outboard bearing lowered until the red lead is wiped on the entire lower main bearing when the shaft is rotated. Under these conditions the shaft is resting equally all along the bearing and it follows that the two bearings must be in alignment. The quarter-boxes should be next set in place and brought up against the shaft.

The wire center line above the shaft should be put in place, and by using plumb-bobs it is easy to see if the shaft is "out." If so, the base must be shifted enough so that when the shaft is again leveled it will be in alignment with the wire.

The connecting rod should then be put in place. As a precaution the engine should be turned over and the distance below the crankpin brasses and crank disk measured at the head and crank ends. It should be understood that the shaft may be out of square with the engine center line a considerable amount before it will be discovered by measuring this connecting-rod clearance. If the shaft is aligned, as indicated, by adjusting the outboard bearing, the engineer may be certain that it is in its correct position.

In case of direct connected units, after the shaft is so aligned it should be removed and the generator frame set into place. The shaft then should be slipped back into place and the generator shifted until it is in correct position on its base or sole plates. The air gap at the bottom of the rotor should be about ½ in. greater than the top air gap to allow for a wear of the shaft bearings.

A recent issue of the British magazine, *Engineering*, told of some interesting experiments with lignite conducted by Professor Bone at the Imperial College of Science and Technology. Professor Bone has made preliminary tests with a byproduct process, in which the fuel is heated out of contact with air to a temperature of 750 deg. F. after it has been dried at a temperature of 230 deg. F. During the process a reduction of weight takes place, due to the elimination of 5½ per cent of water and 6½ per cent by weight of gases. The loss in weight, without appreciable loss of heat, increases the heat value per pound from 10,000 to 11,500 B.t.u. This up-grading process may be produced by the waste heat of flue gases and is believed to be fundamentally similar to the process by which nature has manufactured the bituminous coals from the earlier lignites.

Application and Rating of Busbars and Connection Bars

Standard practice in the rating and application of busbars and connection bars as adopted recently by the Electric Power Club, is as follows: The standards will become part of the Club's Handbook.

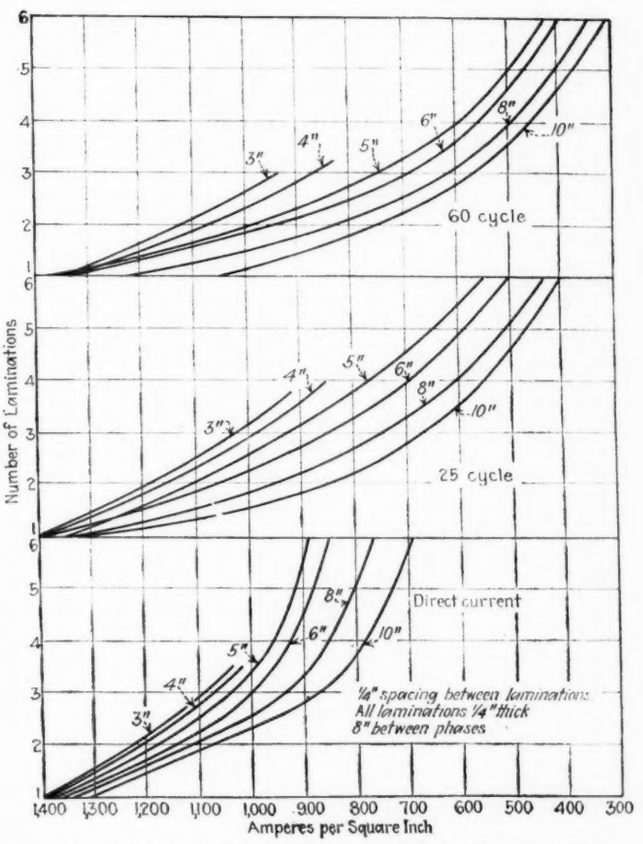
1. On account of the variation in radiation, skin effect and reactance due to the arrangement of busbars, ampere ratings of bus and connection bars shall be based on 40 deg. C. ambient temperature rise instead of on a constant current density.

The curves in the figure cover the current-carrying capacity of the usual sizes of copper buses and are to be used for currents not exceeding 3,000 amperes.

2. A contact pressure of 250 lb. per in. shall be the minimum for good engineering practice in bolted or clamped connections of bars.

3. All contact surfaces of buses and connections shall be cleaned by sandpapering or other suitable means immediately before bolting.

4. On account of the low temperature at which the oxidation of copper begins, a maximum operating tem-



AMPERES PER SQUARE INCH FOR 30 DEG. C. RISE IN COPPER BUSBARS

Slightly increased capacity is obtained by replacing each ¼-in. lamination with two ⅛-in. laminations and using a ⅜-in. spacing between laminations, due to the increased radiating surface. However, this advantage is gradually offset by increased inductance as the number of laminations increase per phase and as the spacing of phases decreases.

perature of 70 deg. C. shall be used in the design of copper buses and the connections thereto, except that on extended bus systems isolated from apparatus where unusually heavy contact pressure is employed at joints and connections, a maximum temperature of 80 deg. C. may be used.

Comparative Ammonia Condenser Reports Point Out Inefficiencies

By P. WILSON EVANS
Motive Power Department, Armour & Company

FOR a number of years Armour & Company have compiled a weekly comparative statement showing data on ammonia condensing for the principal plants. This statement has taken several forms, the form now in use having been adopted about two years ago. It is considered that this statement has certain points to recommend it, particularly in that it indicates on the face of it where to look for conditions that are out of line.

A copy of this report for the week ended Sept. 16, 1922, is presented herewith in tabular form. It will be noticed that columns 1, 2, 3, 4 and 5 comprise statistical data for the period of time in question. The averages shown in these columns for outside temperature, temperatures of liquid ammonia, water on condenser and water off condenser, also the ammonia condenser pressure, are based on readings taken every three hours and submitted to the Motive Power Department in Chicago on the form known as "The Power House Daily Record," which report contains many other items of record in regard to operation of the power houses. The other columns of this report were obtained by calculations from the observed readings. Column 4a does not affect the succeeding columns and is set down to give an idea as to the amount of water being circulated, which of course varies greatly, depending to a large extent on the available water supply at a given plant and the cost of this water. Column 4b is calculated in the two instances where atmospheric-type condensers are not used. In the Jersey City plant the condenser is of the submerged type, and at Spokane a double-pipe condenser is used. It is considered in these cases that comparison is properly based upon the average temperature of the water on and off the condenser instead of upon the final temperature of the water leaving the condenser. It is admitted that this is not entirely correct, but the comparisons made in this manner look consistent with the results obtained with atmospheric condensers.

BY COMPILING weekly averages of ammonia condenser temperatures and pressures from the various plants operated by Armour & Company, it has been possible to detect and remedy inefficient operating conditions, with a resultant saving in power and operating expense. The importance of purging is emphasized by showing that, even in extreme cases, the power saved in one day will more than offset the loss in ammonia vapor.

In this report the important data are shown in columns 8 and 9, and to calculate the same it is necessary to obtain columns 6 and 7, the former of these showing the pressures corresponding to the temperatures of the liquid ammonia and the latter the ammonia pressures corresponding to the temperatures of the water off the condenser. The values shown are taken from the "Table on Properties of Steam and Ammonia," by G. A. Goodenough.

Column 8 is obtained by subtracting the figures in column 6 from those of column 5, so that column 8 shows the difference between the actual condenser pressure and the pressure corresponding to the temperature of the liquid ammonia. It will be noticed that the statement is made in this report that the figures in column 8 show the pressure due to the presence of non-condensable gases in the refrigerating system. The total pressure in the condenser is, of course, made up of the vapor pressure of the liquid ammonia plus the pressure due to the non-condensable gases, so that it is apparent that if the portion of this total pressure represented by the vapor ammonia pressure is deducted, the result will represent directly the pressure of the non-condensable gases.

Column 9 is obtained by subtracting the figures in column 7 from those of column 6. This column then shows the difference between the pressure corresponding to the temperature of the water off the condenser and the pressure corresponding to the temperature of the liquid ammonia. The statement is also made that column 9 represents pressure due to the temperature gradient through the condenser. If there were no temperature gradient, that is to say, if the temperature of the water off the condenser were exactly the same as the temperature of the liquid ammonia, the values in column 9 would be zero. Any condition that increases this temperature gradient also increases the figures in column 9. As stated in the report, two causes tending to increase the column 9 pressures are scale on the condenser and improper distribution of the water.

Column 10 shows the total excess pressure over ideal conditions and is taken as the difference between columns 7 and 5, or as the summation of columns 8 and 9 when the values in both columns are given. It is the endeavor to hold this total excess pressure down to not over 25 lb., but it is difficult to accomplish this. The average on the particular report in question is shown as 25.6 lb. It is only by keeping constantly after this phase of operation that this excess pressure is kept from going considerably higher. Red pencil markings on the copies of this report sent to the different plants, indicate whether the condenser should be purged or other steps taken to reduce the pressure.

In case a plant is found to be materially out of line in its condenser pressure, the question always arises as to how much of a loss in dollars and cents this condition is costing. Cases have arisen where the total excess pressure, as shown in column 10, has been as great as 80 pounds.

There is presented herewith a curve sheet showing the horsepower required to compress adiabatically the

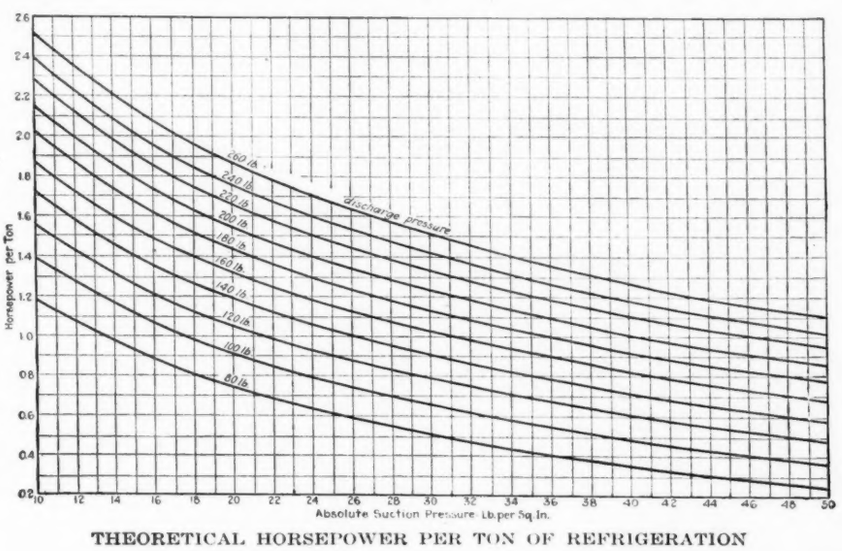
ammonia required to produce one ton of refrigeration, assuming the suction gas dry and saturated. These curves were calculated carefully by the writer and represent accurately the theoretical horsepower required. For an example, take the following conditions which appeared in one of the weekly comparisons:

Average outside temperature, deg. F	39
Average temperature of liquid ammonia, deg. F	55
Average temperature water on condenser, deg. F	48
Average temperature water off condenser, deg. F	50
Average condenser pressure by gage, lb	158

From these readings the following is obtained by reference to an ammonia table:

Gage pressure corresponding to temperature of the liquid ammonia, lb.	84
Gage pressure corresponding to temperature water off condenser, lb.	75
Excess pressure due to presence of non-condensable gases in system, lb.	74
Pressure due to temperature gradient through condenser, lb.	9
Total excess pressure over ideal conditions, lb	83

It is evident that a system showing such results should be purged and that there is a total excess pressure due to non-condensable gases amounting to 74 lb. However, it is not possible to reduce the excess pressure due to the non-condensable gases to zero, but by proper purging this can be reduced to, say, 20 lb., making the total excess pressure, including the 9 lb. due to the temperature gradient through the condenser, equal to 29 lb., which would be considered fair operation and would about correspond with the average obtained in good practice. The operating condenser pressure after purging would, therefore, be 84 + 29 = 113 lb. gage, instead of the 158 lb. originally obtained.



THEORETICAL HORSEPOWER PER TON OF REFRIGERATION

Assume in this particular case that the suction pressure was 10 lb. gage, or 24 lb. absolute, the condenser pressure before purging being 158 lb. gage or about 173 lb. absolute. Under these conditions it will be seen by referring to the curve sheet, that there would be required 1.24 compressor horsepower per ton. If, after purging, the condenser pressure were reduced, as previously indicated, to 113 lb. gage, or 127 lb. absolute, the chart shows that there would be required only 0.97 hp. per ton. The actual electrical horsepower can be assumed as about 50 per cent greater than the ammonia horsepower for adiabatic compression. Before purging, the electrical horsepower per ton would have amounted to 1.86 and after purging to 1.45. A 200-ton refrigerating machine operated at 24 lb. absolute suction pressure and 173 lb. absolute condenser pressure, would produce at its rated speed, with suction gas dry and saturated, approximately 163 tons of refrigeration, requiring 303 electrical horsepower, or approximately 227 kw. After purging, and with 24 lb. absolute suction pressure and 127 lb. absolute condenser pressure, assuming the same output in tons of refrigeration from the machine, it would require 236 electrical horsepower, or about 177 kw. In other words, assuming operation 24 hours a day and the cost of power at 1.5c. per kw.-hr., the operating costs would have been reduced from $82 to about $64 a day, or approximately 22 per cent.

The foregoing, however, is not all, as the reduction in condenser pressure materially increases the amount of refrigeration produced by the machine, since the reexpansion capacity loss is a function of the condenser pressure and increases the horsepower per ton to the extent that when the condenser is operated at reduced capacity, the friction and other losses represent a greater proportion of the total. However, it is not intended to go into this phase of the matter in the present article.

There is a well-grounded prejudice against too much condenser purging on account of the possibility of excessive ammonia loss, but actually the amount of this loss depends largely upon the care taken in purging. In the writer's opinion the most satisfactory method of purging an ammonia condenser is to shut the condenser down and allow water to flow over it until there is no material difference between the temperature of the water going on and coming off. Then observe this water temperature and find from the ammonia table the corresponding condenser pressure. This pressure represents accurately the vapor pressure of the liquid ammonia in the condenser, and if the gage on the condenser shows a higher pressure, the excess is due to non-condensable gases such as air.

The purging should be discontinued at a point somewhat above the pressure corresponding to the water temperature, thus assuring that there will be no great amount of boiling off of liquid ammonia.

By computation it was determined that in this case the total loss of ammonia was 52 lb. At 32c. a pound this would represent a loss of $16.64, but, as shown previously, the saving in power would amount to $18. In other words, with the purging conducted as outlined, the saving in power for one day would offset the loss of ammonia.

The difficulty in purging below the pressure corresponding to that of the ammonia vapor at a specific temperature is to know just when to discontinue it, but this is due to the excessive pressure of non-condensable gases assumed in this case. Under more normal conditions it is satisfactory to discontinue the purging just at or slightly above the ammonia vapor pressure corresponding to the temperature of the water flowing over the condenser. If this is done, the loss of ammonia at all times will be insignificant. Ordinarily, it is considered better practice to purge several times in this manner than to continue the purging to a lower

pressure. It is realized that the assumptions made in the previous example represent excessive conditions and should never be encountered in actual practice. Unfortunately, such conditions happen at times, and a careful check should be kept to see that the conditions are actually what they should be, or if not, to secure a prompt remedy.

DATA ON AMMONIA CONDENSING FOR WEEK ENDING SEPT. 16, '22.

1 Average outside temperature
2 Temperature of liquid ammonia
3 Average temperature of water on condenser
4 Average temperature of water off condenser
4a Spread between temperature of water on and off condenser
4b Mean temperature of water on and off condenser
5 Actual condenser pressure by gage
6 Pressure corresponding to temperature of liquid ammonia
7 Pressure corresponding to temperature of water off condenser. (Pressure corresponding to mean temperature in case of D. P. condensers).
8 Pressure due to presence of noncondensable gases in system—difference between actual condenser pressure corresponding to temperature of liquid ammonia.
9 Pressure due to temperature gradient through condenser—(affected by scale on condenser, distribution of water, etc.)—Difference between pressure corresponding to temperature water on and off condenser and pressure corresponding to temperature liquid ammonia.
10 Total excess pressure over ideal conditions—Difference between actual condenser pressure and pressure corresponding to temperature water off condenser. (This should not be over 25 lb.—Lower if possible.)

	Temperatures, Deg. F.						Pressures					
Column No.	1	2	3	4	4a	4b	5	6	7	8	9	10
Chicago	63	..	68	72	4	..	162	..	120	..	..	42
Kansas City	72	89	84	85	1	..	173	165	153	8	12	20
Sioux City	63	81	58	74	16	..	159	143	135	16	8	24
St. Louis	66	81	57	70	13	..	155	143	125	12	18	30
Omaha	66	77	71	76	5	..	149	132	130	17	2	19
Ft. Worth	78	87	83	85	2	..	183	159	153	24	6	30
Fowler	71	67	58	73	15	..	141	109	122	32	..	19
St. Joseph	68	80	56	76	20	..	156	140	130	16	10	26
Anglo-American	63	77	75	75	..	..	155	132	127	23	5	28
Hamilton	68	..	67	73	16	..	145	..	122	..	..	23
New York	72	88	72	86	14	..	177	161	155	16	6	22
Denver	82	75	55	72	17	..	143	129	122	14	7	21
Jersey City* (1)	74	88	73	77	4	75	152	161	131	..	30	21
(2)	72	97	76	90	14	..	194	189	167	5	22	27
Indianapolis	70	85	64	76	12	..	118	153	130	..	23	12
Spokane†	70	67	51	76	25	64	125	108	101	17	7	24
St. Paul	56	68	52	60	8	..	140	111	93	29	18	47
Average	69.1						155.7					25.6

* Submerged condenser used. † Double-pipe condenser used.

Maphite—New Treatment for Firebrick

Maphite is a natural ore. When it is pulverized, mixed with a liquid to the consistency of a paint and applied to the surface of a firebrick, it causes that surface, when fired, to assume a dark brown hue and a vitreous appearance. The dark material extends for some distance into the structure, as shown in Fig. 1, a reproduced photograph of a brick, so treated, which had been used in the checkerwork of an oil-fired furnace. Beneath the dark coating is a layer of white which has the appearance of china. Both of the vitreous coatings, especially the outer, are so hard that they will cut glass.

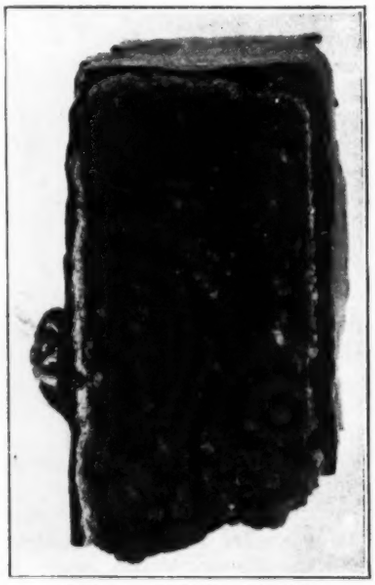


FIG. 1—BRICK COATED WITH MAPHITE

The mixture may be of greater consistency and used as a plaster for the repair of burned-out side walls and arches. Fig. 2 shows the condition of an arch before and after repairing by painting with a couple of coats of the mixture. The repair was made in July and the owners say that, with the exception of a few places that can be readily renewed in the same way, it is still in excellent condition.

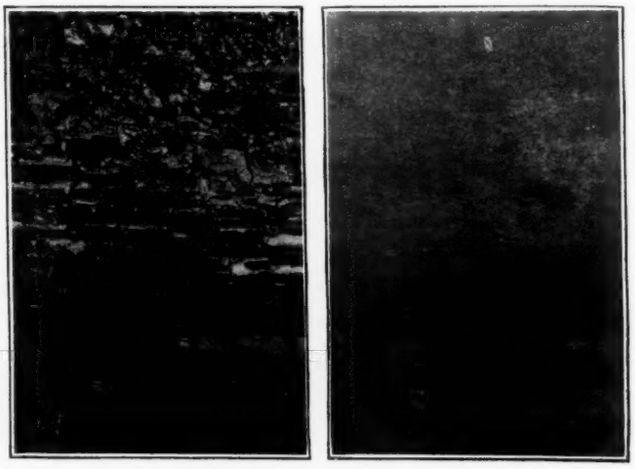
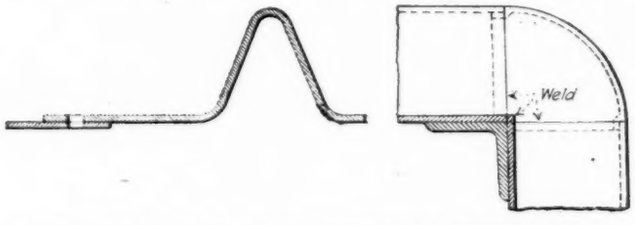


FIG. 2—BURNED ARCH, BEFORE AND AFTER PLASTERING WITH MAPHITE

Both the powdered ore and the liquid with which it is mixed are produced by The Boiler-Kote Company, Chicago, Ill.

Taking Care of Flue Expansion by the "Accordion" Method

An expansion element designed to eliminate warping and buckling in the larger sizes of boiler breeching is shown. It is made of soft open-hearth steel plate, crimped cold in the form of a projecting rib. Such sections, inserted at intervals along straight portions of the breeching and extending completely around the perimeter, take up the lengthwise expansion due to heating, their action being the same as that of an accordion bellows. The ribs stand out about three inches from the flat surface of the flue. At the corners special pieces shaped somewhat like a clamshell and of the same thickness as the rest of the section are electrically welded to the ends of the two plates at right angles, thus making an airtight unit of the entire section.



SECTION AND CORNER OF EXPANSION ELEMENT FOR BOILER BREECHING

This expanding section, whose use eliminates the loose-fitting sliding joint often employed, is made by Connery & Co., Philadelphia, Pa.

EDITORIALS

F. R. LOW, EDITOR

Another Movement in Massachusetts Anthracite

ONE of the outcomes of the present coal shortage is the proposed development of the coal deposit at Mansfield, Mass. This is a very hard graphite coal which burns with such difficulty that numerous attempts to work the mines and market its product have been failures. James Russell Lowell wrote a poem to the effect that on the Day of Judgment the inhabitants would flock to these mines, for the coal would be the last thing in creation that would burn. *Power* of Feb. 15 and Feb. 22, 1910, contains accounts of an attempt by Henry M. Whitney to float the mine and the discovery by Williams of an alleged catalytic which was supposed to render combustion of the coal less difficult.

The coal has been used in a small way for domestic purposes and under forced draft as a fuel for steam boilers. It is possible that improved methods of combustion and the increased cost in New England of other coals may make its mining profitable, but investment in such a project should be undertaken only after a full investigation of the adaptability of the product to the proposed uses and in the light of past experience.

This possibility does not in any way mitigate the iniquity of the scheme now under investigation by the police department whereby orders are taken for "Mansfield Anthracite Coal," with apparently no explanation of its obdurate qualities, at $15 per ton, one-half to be paid on the placing of the order. The mine, according to late reports, consists of a hole some three hundred feet deep, full of water and with no physical indications of any movement in the direction of its operation.

New Graphical Methods Needed

IT WAS in 1899 that a Frenchman named D'Ocagne made a distinct contribution to engineering knowledge by publishing his "Treatise on Nomography." This book, showing how various technical formulas could be translated into ingenious diagrams, was read and applied by a number of American engineers. In recent years, following the publication of books on the subject by J. B. Peddle ("Construction of Graphical Charts") and Joseph Lipka ("Graphical and Mechanical Computation"), many American engineers have mastered the methods of preparing such charts, as evidenced by the numerous examples to be found in technical journals, books and papers before engineering societies.

While, strictly speaking, simple curves plotted on ordinary co-ordinate paper might be classified as "nomograms," the term is here used to refer only to the newer types of diagrams, such as those involving many variables or those using non-uniform scales. Much ingenuity has been expended on such charts, and often the final result is as simple as the original formula was difficult. In most cases no mathematical knowledge is needed in order to use these nomograms.

Where the formulas cannot be properly or easily handled by uniform scales, non-uniform scales are used. The simplest example of this is found in the use of logarithmic co-ordinate paper, which has an uncanny way of turning curves into straight lines and of simplifying the processes of multiplication and division.

Perhaps the neatest of all nomograms are the co-linear charts, which are nothing but a few graduated lines properly located in respect to one another, the solution being obtained with the aid of a straight-edge. In the most common case these are parallel straight lines with logarithmic scales. Such diagrams can easily be constructed to solve any formula involving some or all of the following elements: Multiplication, division, powers and roots.

In spite of the valuable work already done, there still remain many important formulas for which it is difficult to construct simple charts by methods now known. Here is a field where some of our "higher" mathematicians can exercise their abilities to accomplish something of immediate practical value.

The Last Year One of Achievement

A LARGE portion of this issue is devoted to a review of the activities in power-equipment engineering during the last twelve months. If the developments shown by this retrospect mean anything at all, they justify the tendencies of the past in power-plant engineering. Power units have been gradually increasing in size and steam pressures and temperatures increasing in value, and the last year has seen a decided advance in these directions. In 1916 steam temperatures approaching seven-hundred degrees came into use in this country. The troubles encountered had an effect to deter others from attempting the use of such temperatures and for the last four or five years a preference has been shown for steam pressures around three-hundred pounds and with few exceptions, temperatures approximating six-hundred degrees. However, the earlier troubles are gradually being overcome and the last twelve months has seen a decided advance in steam pressures as well as in temperatures, with two plants having boiler pressures of four-hundred pounds and a steam temperature of approximately seven-hundred degrees, and another plant with five-hundred-and-fifty-pounds and seven-hundred-and-twenty-five-degree steam.

The construction of the 45,000-kilowatt single-cylinder turbo-generator unit in 1917 held the record in size for steam turbines in this country until 1922. In fact, for the last three or four years a preference has been shown for units of 30,000- and 35,000-kw. capacity in the large stations. A number of 60,000-kw. machines have been constructed, but they have been of the triple-cylinder cross-compound type. Last year saw the capacity of the single-cylinder machines increase to sixty thousand kilowatts.

In hydro-electric units the record for capacity was again broken with twenty thousand kilovolt-amperes added to the generator capacity and fifteen thousand

horsepower to the turbine, which has advanced the capacity from fifty-five thousand to seventy thousand horsepower, so that the steam and the hydraulic units now are of about equal capacity.

A notable feature of the hydraulic turbine is that in the last three years it has doubled in capacity. From reading the review it is evident that the large hydraulic turbine, like the steam turbine, is the rule and not the exception. Not only has the record been broken for the reaction-type hydraulic turbine, which has come into such wide use, but the propeller type has seen a development that probably surpasses any achievement in power equipment. Only a few years ago this type of wheel was a laboratory experiment, and until last year those that were installed were rated in capacities amounting to a few hundred horsepower. The past twelve months has seen the capacity of these units jump to twenty-eight thousand horsepower in a single-runner machine. If this type of equipment can be developed to prove as satisfactory in operation as the reaction type, its use will mean the development of many low-head water powers that otherwise might be prohibitive in cost. For the same head and capacity the propeller type operates at about three times the speed of the reaction type.

As the new year begins, the engineer can on the one hand, view with pride and satisfaction his accomplishments, and feel that he has been true to his trust; on the other hand, he has unlimited possibilities for future developments, since the task of meeting the needs for power has only begun.

Using Heavy Oil in Diesel Engines

MANY who see heavy Mexican boiler oil sold at a dollar or so a barrel feel that it is a mistake to pay two to three times the amount for a lighter oil to be used in an oil engine. The first impression is that the saving in fuel would mean a decidedly lower cost per kilowatt-hour or horsepower-hour.

It is undoubtedly true that there are Diesel plants where the use of the heavy oil is justified, often imperative. In marine service the oil engine must be able to burn efficiently any petroleum oil that is encountered at the supply stations throughout the world. Stationary plants so located that heavy boiler oil is available while the light fuel oil supply is variable, likewise must be prepared to cope with whatever the market affords.

Taken broadly, however, it seldom pays a Diesel engine owner to purchase a fuel under twenty-two degree Baumé. Assuming a five hundred horsepower engine, with twenty-four-hour service and an eighty-per cent load factor, the total yearly fuel consumption will be close to six thousand barrels per year. At a difference of one dollar per barrel the apparent saving will be some six thousand dollars. This is not all the story. The heavy-oil will entail more shutdowns for valve grinding, piston cleaning, etc. A plant of this capacity represents a possible operating worth of, say, thirty dollars an hour. It would require only a total of two hundred hours of shutdown a year to offset the fuel saving. There would be an increase in the repair and labor charges, this being at least fifty per cent of the total fuel cost. The increased repairs due to the sulphur in the heavy oil cannot be ignored. The balancing of the savings and increased expenses indicates that the heavy oil is not always the cheapest.

There are, as has been indicated, many installations where the heavy oil must of necessity be used. Under such circumstances there is no logic in passing over the Diesel engine and installing a steam plant where the local conditions otherwise favor a Diesel. The heavy oil can be used with success, even if at increased labor and repair expenses, but proper precautions must be taken.

The oil must be heated and arranged to flow by gravity to the engine fuel pump, or the pump will not be able to handle the thick fluid. Gas binding, irregularity in governing and racing of the engine are some of the troubles encountered when the pumps are required to lift cold oil. In many engines the compression pressure must be raised slightly to give a final temperature sufficiently high to ignite the heavy fuel. This increased compression may be avoided if kerosene or distillate is used when starting, switching over to the residuum as soon as the engine becomes warm. When the engine is heated to its running condition, the intake air temperature is high enough to give an igniting final temperature with the customary Diesel compression ratios.

With respect to semi-Diesel engines the generally accepted view is that this type of engine will not handle heavy oil satisfactorily. This does not mean that no semi-Diesel has operated on boiler oil. But the poor results obtained, especially on varying loads, the increased repairs and overhauling make the heavy oil impossible in installations when reliability of operation is essential.

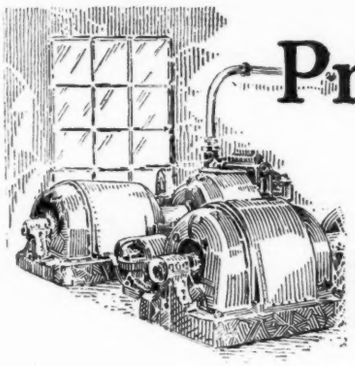
Viewed from all sides one may conclude that unless the price differential is great, boiler oil is not advisable in Diesel plants and never in a semi-Diesel engine.

Capitalizing Operating Difficulties

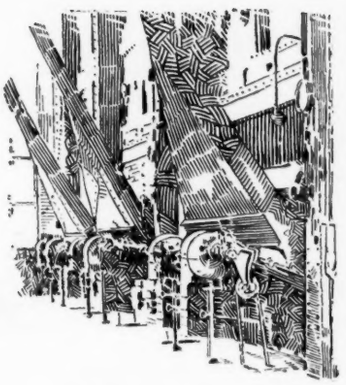
WHEN a new design of prime mover or other machine is first placed in commercial operation, trouble in some form is naturally expected. While a flawless "starting off" is extremely welcome, it is usually realized that the record in after years is what really counts, and therefore great importance should be attached to checking thoroughly adjustments and investigating possible difficulties. "Trouble," properly handled, is really a guarantee of future security.

In the course of operation difficulties are at times encountered, due to conditions in the plant or perhaps to circumstances which the manufacturer largely controls; the real responsibility and consequent expenditure involved is often a subject of controversy. Correcting such conditions may effect a relief, but using the knowledge obtained in other ways may result in more far-reaching gains.

By analyzing the factors causing troubles and drawing attention to the financial necessity for increased reliability, the way is paved for greater improvement. United action by purchasers and manufacturers in defining the flexibility or thrust of piping allowed on the prime movers, and other conditions involving installation or operation in well-understood units, provides a definite basis on which manufacturer and purchaser may co-operate. Furthermore, calling attention to requirements of reliability by engineering associations, will probably result in such requirements being more widely understood by those who must pay an additional investment for greater reliability: the higher, non-technical executives immediately involved and—in the long run—the public.



Practical Ideas *from* Practical Men



Electrical Conductors Installed in Damp Places Should Be Lead Covered

In a power station where it was definitely known that some of the conduits contained water, the ground lamps finally indicated that a ground existed on the 6,600-volt apparatus. The ground was found to be caused by water in a fiber conduit containing a generator cable and was cleared by withdrawing the cable and supporting it on insulators. All the 6,600-volt cables were provided with braided covering, and it was decided to requisition sufficient lead-covered cable to replace that in use. However, before the lead-covered cable arrived, simultaneous grounds developed on different phases of two generators, causing a short-circuit. This damaged one generator to such an extent that rewinding became necessary, and caused a suspension of service from this plant of 45 minutes. Had ground lamps not been provided, it is probable that a short-circuit would have given the first intimation that the 6,600-volt apparatus was grounded, hence the real advantage of some reliable ground detector is apparent.

It is an easy matter to megger station equipment, and had this been regularly done, it is probable that the deterioration of the cable insulation would have been detected much sooner than was the case where the indications of the ground lamps alone were depended on. There is nothing new in the statement that lead-covered conductors should invariably be used in places where there is the least likelihood of moisture collecing, yet owing to ignoring this elementary fact a large generator was badly damaged, a large percentage of the output of an important station was curtailed, and lead-covered cable was eventually required, at increased expense. This instance should serve to emphasize the fact that electrical conductors must be kept free of moisture, or damage out of all proportion to the cost of keeping such conductors dry, either by a covering of lead or by watertight conduits, will eventually result.

Belden, Calif. RALPH BROWN.

Hints on Being Chief Engineer

Most engineers in a power station, especially the younger ones, aspire to the chief engineer's position.

Each man, in his own estimation, thinks that he could handle the job if given a chance at it, and he is sure that he would do things differently if he were chief; but how few have stopped to think just what it really means to be chief—what he has to know, what he has to do and the many conditions and emergencies that he has to meet.

Personally, as a young man, I was no exception to the rule. I wanted to be the chief. I realized that a man should know a great deal, so I studied and finished a course in steam engineering. I also took an examination and secured a license for the state in which I lived at the time. Another qualification that I lacked was wide or varied experience, so I changed from plant to plant.

After some twelve years' experience from fireman up to a graduate licensed operating engineer in small plants, I thought that surely I was qualified to be chief, and finally the opportunity came for me to go to a neighboring city and take charge of an electric railroad power station of no mean capacity.

It was a gas-engine plant and it looked like a mountain to me. When I arrived at the plant, one unit was running, two others leaked so badly that they could not get them started, and the fourth was undergoing repairs.

I don't know how I ever got through the first few months in that plant. I found that while I had a good *working* knowledge of machinery, there were lots of things about running a power plant that I did not know. I soon realized that I had made a mistake in devoting all my time and energy to learning how to repair, how to operate, and how to locate trouble, on the different types of machines, but had never given a thought as to how I was going to get someone else to do it for me. I did not know what I should do myself and what I should expect of my help. If the engines slowed down from heavy load or other cause, it made no difference how busy I was, I would drop everything and rush to find out the trouble. When a machine was to be paralleled I was afraid that the operator would make a mistake, so I usually did the work myself. I listened to all the little petty grievances of the men and felt that I had to get along with them instead of their getting along with me. If a man had to be off, instead of requiring the other crews to work overtime, I would run the shift myself.

However, after fifteen months' hard work, I had a pretty smooth operating plant, but I was about as much of a wreck as the plant had been when I took charge of it. In one way I had made a great success of this, my first chief's job, and in another way a failure. I had built up the plant, but had run my "morale" down and little troubles began to look like mountains, and eventually, my mental condition was such that I had to give up to recuperate.

Another thing that a chief is up against—he has to satisfy the "office." If he sees where he can improve things, he usually has to "sell" his idea to the office before he can proceed. He also, oftentimes, finds himself compelled to get along with inferior help at low

wages, when he should be allowed to pay enough to get the best help obtainable. A cheap man is dear at any price around a power plant.

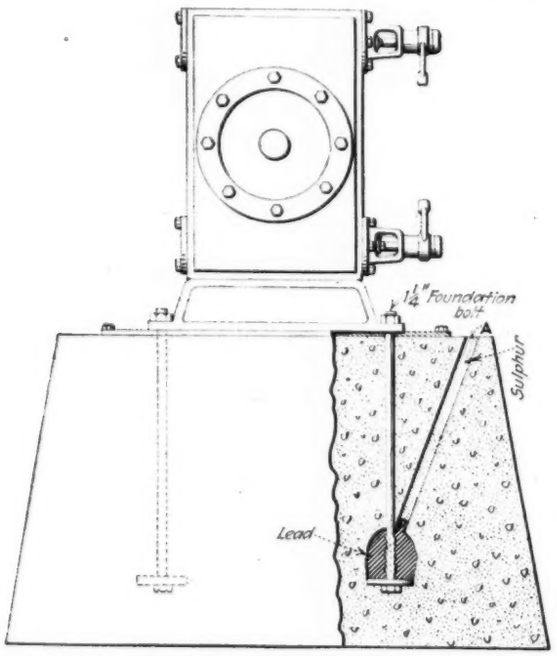
A chief should not be loaded up with details as I allowed myself to be. The operation and routine should be delegated largely to subordinates and the chief left free to plan how he can improve the operating condition and efficiency of the plant, also future extensions. Such a small thing as a saving of one-tenth of a cent per kilowatt-hour will more than pay all the wages in a good-sized plant.

I do not say it boastfully, but I have held other important positions since the experience stated, but I do not consider that I am an expert chief yet.

Detroit, Mich. G. A. BRISTOW.

How a Loose Foundation Bolt Was Tightened

In a wood-working plant on Long Island a loose foundation bolt on the crank end of an 18x36-in. Corliss engine allowed the cylinder to "move" at every revolution, and with any overload the condition was dangerous. The plant was an old-timer, and no information relative to the construction of the foundation was obtainable. It appeared to be a solid concrete block with the bolts built in. The loose bolt could be drawn up about 6 in. by hand, and it was assumed that the concrete at the lower end of the bolt had not been properly



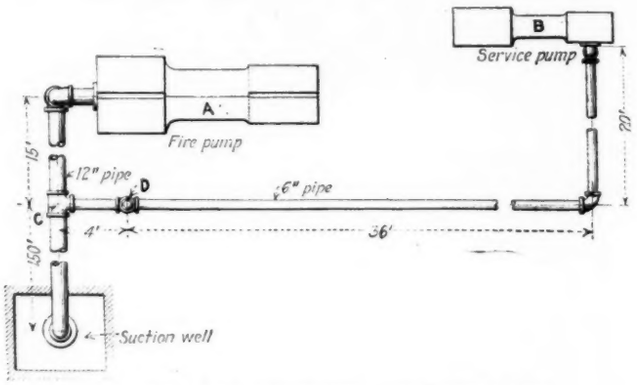
HOLE WAS DRILLED IN FOUNDATION AND CAVITY FILLED WITH LEAD

mixed or tamped. The length of the bolt was unknown, but a 1¼-in. hole, as shown at *A* in the cut, was drilled in the foundation. At a depth of 3 ft. the hole was struck. A 100-lb. bar of pig lead was then melted, and while it was heating a red-hot rod of iron was thrust in the drilled hole to warm the concrete, to prevent the lead from cooling as it was poured. After the lead had cooled, the drilled hole was filled with sulphur. The nut was then screwed down tight, and the bolt was found to be firmly set.

Camden, Me. M. M. BROWN.

Faulty Layout of Suction Pipe Causes Poor Operation of Pumps

The water-pumping equipment of the plant with which I am connected, consists of an underwriters' duplex fire pump and a simplex service pump that is used about three hours each day to furnish water for certain processes in the mill. We experience considerable trouble from time to time in the operation of these



GENERAL ARRANGEMENT OF PUMPS AND SUCTION PIPING

pumps, owing to faulty layout of the suction line, the arrangement of which is shown in the cut. The pumps work satisfactorily when all valves are in good condition, but after the valves in either pump get partly worn, the trouble begins. The fire pump *A* has a 12-in. suction line and is located approximately 165 ft. from the well, with a vertical rise of about 8 ft. from the surface of the water to the run of pipe and 5 ft. more lift from the run of pipe to the inlet of the pump. The service pump *B* has a 6-in. suction line and is connected to the main 12-in. suction at a point 150 ft. from the well. This line is fitted with a 6-in. swing check valve *D* placed 4 ft. from the main suction. This was intended to prevent leakage of air back through the 6-in. line, which would of course interfere with the proper operation of the fire pump. For several years it worked very well, but there has always been more or less trouble when starting the pump *B* to get it to prime.

Recently, while installing a new set of valves in the suction side of pump *A*, it occurred to us that air was leaking in through the rod packing and the old valves in the pump, to the suction of the pump *B*. Further investigation showed that poor valves in *B* caused *A* to run unsteadily, but that new valves in *A* did not help the performance of *B* to any great extent. This indicated that the check valve *D* was leaking. This valve was then examined and it was found that the hinge of the disk had worn sufficiently to allow the disk to swing to one side and not fully cover the seat. This accounted for the poor operation of the pump *A* when the valves in pump *B* began to get a little worn or when anything got under them to keep them off the seat. A new check valve was ordered, and after it was installed the operation of both pumps was much improved.

However, it is my opinion that for satisfactory service there should be a foot valve on the main suction pipe at the well and a check valve between the tee *C* and the pump *A* or an independent suction for each pump.

North Grafton, Mass. W. E. CHANDLER.

Comments from Readers

Is Too Much Expected of the Engineer?

The article by W. A. Anderson in the Nov. 28, 1922, issue, undoubtedly calls for a reply, and the following is my opinion:

An employer seldom looks for more than is humanly possible from an employee, and where engineers are concerned, he hardly knows what to expect. He does, however, have the same right to expect action from his engineer that he would have to expect it from any other employee.

Obviously, the engineer's place, first of all, is in his plant, and if he has the inclination he can usually find enough to keep him busy in his own department. It is often the case, however, that his own routine becomes monotonous and that of his own volition he seeks adventure elsewhere.

Mr. Anderson's article portrays to my mind an engineer who spends as little time as possible with the machinery that he is entrusted to operate. I picture him rushing in at about five minutes before starting time, hurriedly throwing a little oil at the engine governor, giving the throttle a twirl, and remarking to himself "express for quitting time." If this were not the case, the engineer would more than likely have found a loose setscrew that nearly caused a wreck.

The ideal time for a superficial examination is while oiling up. In the case of a twin-tandem triple-expansion engine of the Corliss type, it will readily be seen that the work of oiling up, examining valve gear, etc., requires some little time, but is necessary if shutdowns are to be avoided.

What is true of the large plant is equally so of the small one, and if the engineer performs his duty as he should with respect to operation, maintenance and cleanliness, and above all keeps an accurate record pertaining to operating costs, etc., he can not find time to repair the mill machinery while his plant is in operation.

C. C. GARDNER.

Morgantown, N. C.

Charging a Refrigerating System

It seems to me that the refrigerating system Mr. Grow refers to in *Power*, Nov. 7, 1922, is short of two important fixtures. There should be a gage glass on the ammonia receiver and a stop valve on the receiver outlet pipe.

With the exception of very small plants all the newer refrigeration systems have these fixtures, and old plants should by all means have them installed, as the operation and charging of the system is made easier and safer.

The amount of ammonia circulating in the condensing and freezing ends of a refrigerating system varies according to the temperatures and pressures under which the plant is operated. There must be a container to store or furnish ammonia to these parts in accordance with the demand. This is the function of the ammonia receiver, and under all working conditions enough liquid ammonia should stay in the receiver to seal the outlet against gas blowing through to the expansion valve.

Whenever the liquid ammonia level in the receiver, as can be seen from the gage glass, drops below the safe limit, more ammonia has to be charged in the system. A cylinder of ammonia is connected to the charging valve, which is generally near the receiver in the liquid line between the receiver outlet stop valve and the expansion valve. The receiver outlet valve, often called the king valve, is closed next, and the expansion valve opened three to four turns. The condensing pressure in the liquid line will soon drop to the pressure in the freezing system, and the charging valve is then opened wide and the outlet valve on the ammonia cylinder opened enough to keep up the usual suction pressure on the freezing system. The valve on the ammonia cylinder now acts as the expansion valve.

As all parts of the plant are kept in their normal running condition, the compressor draws the gas from the freezing system and discharges it to the condenser, after which it flows as a liquid into the receiver. Since the outlet valve on the latter is closed, the liquid level will rise, and as soon as the gage glass shows the level at the proper height, the valve on the ammonia cylinder is closed. There will be some frost on the pipe connecting the cylinder with the charging valve, and the melting of this frost is a sign that only dry gas is left in the cylinder. The charging valve is then closed, the expansion valve set to its normal position and the king valve opened, putting the system back to its regular working condition.

This practice answers for small installations. For larger plants, where more than one cylinder of ammonia is needed for recharging, it is advisable to have before the charging valve a header with two inlets at about 30-in. centers, a stop valve on each inlet and a short connection to the ammonia cylinder. By this arrangement a full cylinder can be connected up while another one is discharging. If the compressor is large enough to hold the suction pressure within safe limits, the ammonia cylinder valve can be opened wide and a cylinder emptied of its liquid contents in six to eight minutes. A 40-ton capacity compressor will take care of the gas from 100 lb. of liquid ammonia in that time; with still larger compressors running at constant speed, the suction pressure can be kept within suitable limits by feeding some liquid from the receiver through the king valve.

To get all the liquid out of the charging cylinder, the valve end is set about six inches low, so all the liquid drains toward the outlet. After emptying the cylinder it will be filled with ammonia gas, which, at ten pounds pressure, amounts to about a third of a pound. It does not pay to pump down in order to save this. There is some risk of air being drawn in the system, which must be purged out again.

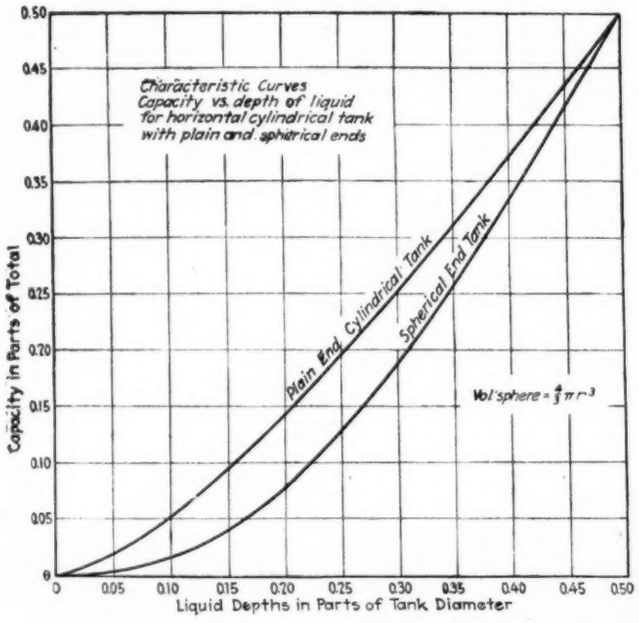
FRED KAISER.

Lansdale, Pa.

Contents of Horizontal Tanks

In *Power*, Nov. 7, appeared a table showing the contents of a horizontal tank at each two-inch increase in depth. Although there was a table of factors whereby the contents of a tank of any size could be computed, the process is complicated.

A better arrangement is shown in the chart herewith. It does not matter what the diameter of the tank is nor the depth of oil, this chart allows the contents to be



PERCENTAGE OF TANK CONTENTS AT ANY DEPTH

found if the total tank contents be known. As example, if the tank was 10 ft. in diameter by 32 ft. long and had flat heads, it would hold 18,800.64 gal. Suppose the tank showed 22 in. of oil. This is $\frac{22}{120}$ of the total depth, or 18⅓ per cent. Reading the chart, it is found that the oil is approximately 12.5 per cent of the total capacity of 18,700.621, or 2,350 gal. This is within 15 gal. of the actual amount. If close accuracy is desired, this chart may be plotted on a large cross-section paper. It is an easy matter to substitute actual inches in any given tank for the percentage scale of tank depth.

Springdale, Pa. H. WEISBERG.

Some Important Factors Neglected

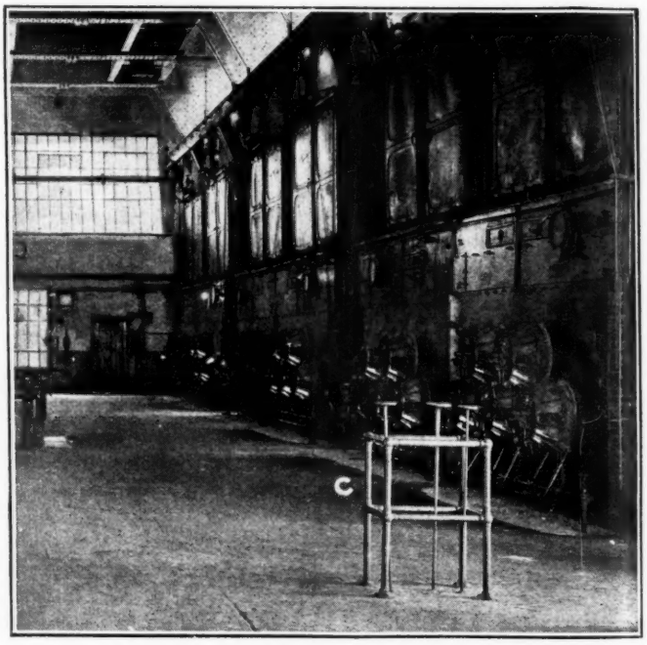
I read with great deal of interest the letter by Hugh E. Weightman in the Nov. 7 issue on "Some Important Factors Neglected." Mr. Weightman writes with considerable understanding concerning a number of interesting points connected with the use of various fuels for steam purposes.

However, I do not believe that the matter of proper furnace construction has been neglected to so great an extent as he would infer, as otherwise the high boiler capacities and high efficiencies being obtained in modern plants, particularly with oil fuel, would scarcely be possible.

Another point made by Mr. Weightman certainly needs further comment, although his view may be readily understood in view of the fact that the development of the wide-range mechanical atomizer is a recent one. He says: "Where the load on the [boiler] units is variable, the mechanical burner is at a disadvantage, since, in the writer's opinion, it will not atomize the oil properly at less than full capacity. Often there is not room at the furnace front to install enough burners of the mechanical type to take care of the extremely variable rating."

Mr. Weightman is speaking from his experience with the ordinary type of mechanical atomizer and is quite correct in his view that with this burner there is a distinct limitation in capacity range. The wide-range mechanical burner was, as the name implies, developed for the express purpose of eliminating this deficiency, and experiments have shown that it is possible to secure a range in boiler capacity from practically a "banked fire" condition to full load without change of the size of tip and without extinguishing or lighting up any of the burners. All burners are kept in service throughout the entire range.

This wide range is accomplished by bypassing a certain proportion of the oil from the central chamber of the tip after it has acquired full centrifugal force, and returning the same to the storage tank or pump suction. It is a further advantage that any number of burners may be controlled by means of a single valve, which may be located at a point remote from the boilers if desired. Thus, any number of burners may be controlled by one man over the entire range of capacity, operating from a central point, which may readily be fitted up with instruments for determining the proper mixture of air for the various loads, and thus high efficiencies may be obtained in daily operation throughout the capacity range.



ALL BURNERS ARE CONTROLLED FROM ONE POINT, FOR LOADS VARYING FROM 50 TO 250 PER CENT OF RATING

This system is a radical departure from the old method whereby each individual burner was controlled as a separate unit by a fireman who, through faulty judgment or indifference, frequently failed to secure anything like the proper combustion.

The illustration shows six of the eleven boilers of the American Sugar Refining Co., at Boston, Mass.,

which are fitted with 55 wide-range burners. The illustration shows the control station in the right foreground at *C*, where one man controls the entire equipment over an extremely fluctuating load, varying from one-half of rating of the boilers to 250 per cent of rating.

The monthly statements of efficiencies at this plant have shown an average for the last two years of about 79 per cent, notwithstanding the fluctuating loads, and including the Sunday shutdown periods.

New York City. E. H. PEABODY, President,
Peabody Engineering Corporation.

Reducing Boiler Pressure Quickly

Being interested in an article by R. A. Cultra in the Nov. 14, 1922, issue and in the comments made by R. G. Spooner in the Nov. 28 issue on "Reducing Boiler Pressures Quickly in Emergencies," I would like to ask some readers of *Power* what they would do in a particular emergency such as I experienced some time ago with a waste-heat boiler of 3,000 sq.ft. heating surface.

The boiler was connected between an open-hearth steel furnace and the chimney by means of a bypass in the breeching fitted with a heavy heat-resisting wing valve for closing off the heat to the boiler. The boiler location was such that there was no steam available for operating the feed pump at starting, so it was operated on air, and after sufficient pressure was raised in the boiler, the feed pump was switched over to operate on steam.

However, when we attempted to start the feed pump with the steam pressure, it would not work, and upon switching back to air it would not work. As the pressure was 140 lb., there was no means of getting water into the boiler.

An attempt was then made to close the damper to shut off the waste heat. This, as was afterward found, could not be closed on account of the bricks in the floor of the tunnel rising up. This, therefore, left the boiler under pressure with no means of getting water in and no means of shutting the waste heat off.

In addition to this, owing to the open condition of the building a gust of cold wind cracked the water-gage glass so that we had to depend on the gage cocks to test the water level. J. R. WATSON.

Chicago, Ill.

In the Nov. 28, 1922, issue, R. G. Spooner comments on the article of Mr. Cultra in the Nov. 14 issue and states that he does not think it consistent with safety and good practice to reduce the boiler pressure by opening the safety valve. His theory of a large body of water being evaporated rapidly so that the pressure accumulates in the boiler and cannot escape fast enough, is in my opinion rather far-fetched. A safety valve that is placed on a boiler, is large enough to relieve the pressure, provided it complies with the state laws. If the valve is blocked open, there is no more danger than if it were opened by over-pressure in the boiler.

Some time ago I had a 3½-in. safety valve on a 60-in. horizontal return-tubular boiler that would blow off at 90 lb. and did not stop until the pressure had reduced to 60 lb. This happened several times. Upon taking the valve apart it was found that the holes under the huddling chamber were partly plugged. After these were cleaned out, it worked all right. Why did not the pressure rise in this case?

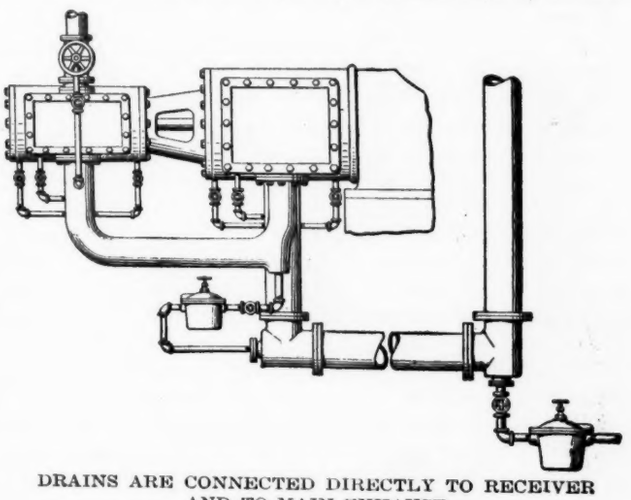
Only recently, in a certain large plant the pipe to the steam gage was broken and the chief engineer had the boiler cut out and the safety valve blocked open. I believe that considerable water flashes into steam as the safety valve is opened, and with a large opening (like a steam main bursting) there is danger of an explosion, but not in the way that Mr. Spooner explained.

If it were necessary for me to relieve a boiler of pressure and there was no way that it could be bled, I would block open the safety valve and feel safe in so doing. I do not believe in pulling a fire, as too much heat is stirred up, and in my opinion it is much better to smother the fire with ashes or coal.

Boston, Mass. F. C. EASTON.

How Should the Cylinder Drains of a Compound Engine Be Connected

I have read with much interest the article by Mr. Brodsky in the Nov. 28 issue, in which he advocates connecting the drains of steam cylinders, receivers, etc., as shown in the cut. It is my opinion that there are



DRAINS ARE CONNECTED DIRECTLY TO RECEIVER AND TO MAIN EXHAUST

better and obviously safer methods of handling cylinder and receiver drainage than the method he suggests.

For example, a steam trap of correct design and capacity connected to the high-pressure cylinder and throttle drain, with a separate trap for the low-pressure cylinder and receiver with their discharge leading to some point other than the engine exhaust pipe, is to be preferred to the method shown.

When operating the engine, condensing or changing from condensing to non-condensing operation, the trap connected between the receiver and the exhaust pipe might fail to function properly just at a time when proper and positive operation was necessary. In connecting the traps as shown, a great deal of reliance is placed on a low-pressure trap since the one connected to the low point on the exhaust line must handle not only the water resulting from pipe condensation, but all water from both steam cylinders, receiver and throttle valve drain as well.

It is important, when installing steam traps, to provide bypass connections for drainage when the trap is out of order or being repaired.

In addition to the usual drain connections on steam cylinders, spring-loaded relief valves arranged to discharge directly to the atmosphere, are desirable protective devices. C. T. BAKER.

Atlanta, Ga.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Reversing Throttle of Two-Cylinder Engine

We have a two-cylinder reversible engine. There is a steam chest between the cylinders. The valve to each cylinder is like a plain slide valve and each is operated by an eccentric fixed 90 deg. with its crank. The engine is reversed by moving back or forth a slide valve in the bottom of the steam chest. How do the valves operate? J. M.

The reversing valve, sometimes called a reversing throttle valve, is like a D-valve. When in middle position, it covers two steam ports. Between these ports is an exhaust passage leading directly to the main exhause pipe, just as provided for an ordinary D-slide valve. When this reversing valve is moved to one side, one of the ports is put in communication with live steam from the boiler and the steam is delivered for outside admission by the main cylinder valves, while the other passage, which comes into communication with the exhaust pipe, is in communication with the under sides of the main cylinder valves, thus permitting operation of the D slide valves on the cylinders in the ordinary manner with outside admission and central exhaust.

When the reversing valve is moved to the opposite position, its port that was in communication with the exhaust pipe is put in communication with live steam which then is delivered to the under side of the cylinder valves, while the passage of the reversing valve, which was connected with the outside of the cylinder valves, is put in communication with the exhaust pipe.

By thus exchanging the steam and exhaust connections of the cylinder valves from outside to inside admission or inside to outside admission, the exhaust side becomes the live-steam side of each piston and the engine is reversed. The operation is the same as illustrated diagrammatically on page 623, Oct. 17 issue, showing the arrangement of a reversing throttle for a single cylinder. Evidently, two or more cylinders can be controlled by a single reversing throttle by connecting one port of the reversing valve with all cylinder valves so as to obtain forward motion of the engine and having the other port of the reversing valve connected with the exhaust of each cylinder valve for forward motion.

Operating Induction Motor with Resistance in Series

On a 220-volt, 25-cycle circuit, it is desired to run a small induction motor that is wound for 110 volts, 25 cycles and 3.4 amperes, and this is my solution of the problem. With 110 volts and 3.4 amperes the circuit would have 110÷3.4=32.4 ohms resistance. Since the voltage on the line is twice 110, or 220 volts, then it will be necessary to insert in series with this motor a resistance equal to 32.4 ohms in order to hold the current to a value of 3.4 amperes. Now 110×3.4=374 watts, say 375. Could a lamp of 110 volts and this wattage be put in circuit to supply the necessary resistance? I know that this would not be good practice as double the wattage would be used; a transformer being the practical thing to use, but could a lamp be used whose resistance is equivalent to the motor so as to hold the current of the motor at its proper value? T. W. C.

If you are going to operate the motor with a resistance in series with it, to maintain 110 volts at the terminal, on a 220-volt circuit, the load on the motor must have a constant value, such as driving an electric fan. If the load decreases, the voltage will increase at the motors terminal and with no load will become almost equal to line voltage.

On account of the resistance connected in series with the motor, changing the power factor of the load, your method of calculating the necessary resistance is not correct. However, this is about the best that you can do unless the characteristics of the motor are known, and is close enough for all practical purposes. Lamps can be connected in series with the motor to give the necessary resistance, but to get 32 ohms resistance with lamps, there would have to be seven 50-watt units connected in parallel. The way to do this is to fix up something that will give approximately the resistance wanted and connect the equipment up with a voltmeter across the motor terminals, after which the resistance may be adjusted to give the desired voltage at the motor.

It may be that the motors connections can be easily changed so as to operate on 220-volts direct. For example, it may be that the windings are made up in two groups, the two groups being connected in parallel. If this is the case, connecting the two groups in series will make the winding suitable for use on 220 volts.

Choice of Boiler Pressure for Steam Supplied to Reducing Valve

At present we carry 100 lb. steam pressure on our boilers, which supply the steam through a reducing valve for operation of a dry kiln with steam at 14 lb. pressure, with good results. To save fuel it has been proposed to reduce the boiler pressure to 60 lb. and keep the reducing valve set for delivery of steam to the kilns at 14 lb. If that is done, could as high a temperature be maintained in the kiln, or would lowering the boiler pressure result in a saving of fuel? R. G. T.

In the case of supplying steam to the reducing valve at 100 lb. gage pressure, reduced to the pressure of 14 lb. gage, the temperature of the steam immediately as discharged through the reducing valve would be 298 deg. F. That is, the steam would be superheated 50 deg. F. above the temperature of dry saturated steam at 14 lb. gage. In the same manner, when the pressure of

the supply is 60 lb. gage reduced to 14 lb. gage, the temperature of the steam on the discharge side of the valve would be 288 deg. F. or superheated 40 deg. F. above the temperature of dry saturated steam at 14 lb. gage. But, in either case, the superheated condition can be considered to exist only in the immediate vicinity of the reducing valve. Since condensation takes place in the heating coils of the kiln for relatively little radiation, the loss of heat is replaced and the coils are kept filled with dry saturated steam at no higher pressure than 14 lb. gage, which has a temperature of 248 deg. F. regardless of whether the initial steam is supplied at 100 or at 60 lb. gage. In either case the superheating in the immediate vicinity of the reducing valve simply assists in counteracting the loss of heat by radiation the same as if the coil were directly supplied with dry saturated steam at 14 lb. gage pressure and heat contributed in form of superheat at the reducing valve were received by the coil from the outside for sustaining the steam in the coils in a saturated condition. Hence there would be practically no difference in effectiveness of the coils whether steam is supplied to the reducing valve at 100 or at 60 lb. gage.

In each instance the boiler would be called upon to supply the same amount of heat. In case of generating steam at 60 lb. gage a little more feed water would have to be handled and there might be a little better boiler efficiency, but for the same results from the coils the difference in fuel economy would be inappreciable.

Lost Motion Adjustment of Duplex Pump

How is the length of stroke of a duplex pump adjusted? R. C. L.

The length of stroke is varied by adjustment of lost motion of the valve gear. The steam valves are made without any inside or outside lap, reaching from the outer edge of one steam port *A*, Fig. 1, to the outer edge of the other steam port. Hence as soon as steam is cut off from one end the exhaust *B* of that end is opened while the other end is opened for steam and its exhaust is closed. Earlier or later cut-off is affected by the position of the lost motion nuts *C* on the valve stem

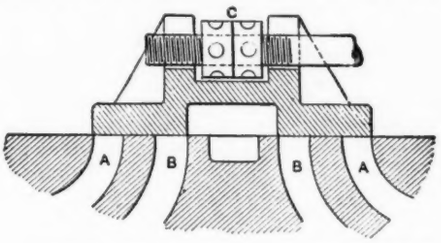


FIG. 1—INSIDE FIXED LOST MOTION

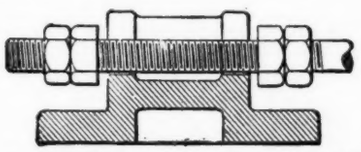


FIG. 2—INSIDE ADJUSTABLE LOST MOTION

between slotted projections on the back of the valve. Evidently the farther these nuts are moved to the left the earlier will cut-off and exhaust occur on the opposite end of the valve and the length of stroke would be shortened on that end. This means of adjustment usually is provided on small pumps, but the total amount of lost motion is fixed and cannot be altered except by changing the thickness of one or both nuts, or the lost motion can be reduced by inserting a washer between the jamb nuts.

Larger pumps usually are fitted with jamb nuts on the valve stem at each end of the valve as shown in Fig. 2, thus affording greater facility in making adjustment, as it sometimes happens that one side of the pump

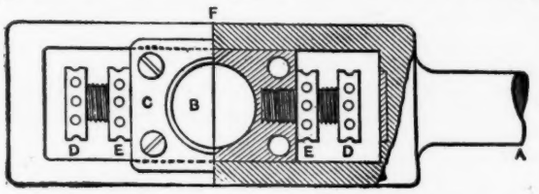


FIG. 3—OUTSIDE ADJUSTABLE LOST MOTION

needs a greater or less amount of lost motion than the other.

On large pumping engines that are operated by skilled attendants and where adjustment of the lost motion often may be required to compensate for changed conditions of operation, the clearance is provided in a lost motion link, Fig. 3, that is outside of the steam chest and which can be adjusted while the pump is moving. The valve stem *A* is provided with a yoke *F* driven through the sliding block *C* that is moved by having the rock shaft pin to pass through the hole *B* in the sliding block. The amount of lost motion is adjusted by the capstan head set screws *D* which are fixed in place by jamb nuts *E*.

Capacity of Ammonia Compressor

What is the method of calculating the capacity of an ammonia compressor? W. L. R.

The formula for the theoretical capacity, in tons of refrigeration per 24 hours, of a double acting compressor, taking into consideration the specified pressures in the condenser and the refrigerator, is the following:

$$T = \frac{d^2 \times 0.7854 \times 1 \times 2 \times N \times h}{1728 \times 200}$$

T = tons refrigeration in 24 hours,
d = diameter of compressor in inches,
L = stroke in inches,
N = number of revolutions per minute,
h = refrigerating effect of one cubic foot of ammonia vapor at refrigerator pressure, completely evaporated from liquid at condenser pressure $= \frac{H_1 - h_2}{c}$
200 = B.t.u. per minute, equivalent to a duty of one ton refrigeration,
c = number cubic feet of vapor in one pound of ammonia at the suction pressure,
H_1 = total heat in one pound of ammonia vapor at the suction pressure.
h_2 = heat in a pound of liquid ammonia at receiver pressure, to be obtained from tables of properties of ammonia.

For single acting machines divide by 2.

This theoretical capacity must be reduced from 10 to 40 per cent to correct for slippage, cylinder heating, etc.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Detonation in Internal-Combustion Engines*

Except for some comparatively recent work practically all the study of gaseous detonation that has been made has been conducted in atmospheric tubes or under other conditions that did not simulate those of internal combustion. From an economic standpoint, however, the detonation that occurs in internal-combustion engines is of great importance.

For any given fuel the intensity of detonation varies with the compression of the engine—the higher its compression the more pronounced the detonation. It is herein that the seriousness of detonation in internal-combustion engines lies, for both the torque and the fuel economy of an engine are increased as its compression ratio is raised.

In spite of the fact that gaseous detonation is not well understood, many theories have been advanced to explain the phenomena that occur in internal-combustion engines variously known as "detonation," "knock," and "pinking." Aside from those which may be classified as mere speculations, three theories have been advanced in definite form.

The first of these, known as the mechanical knock theory, explains the sound as resulting from an actual impact between parts of the engine, such as between cylinder wall and piston or between shaft and bearings. This theory does not attempt to explain the cause of pressures which must exist in the engine cylinders to produce these mechanical impacts. For this reason it may be passed over with this simple mention.

A second theory is that which explains the sound and attendant phenomena of detonation as resulting from a very rapid increase of pressure in the engine cylinder. According to this theory a portion of the charge is compressed to its auto-ignition point by the expansion of the portion first ignited, which compresses before it the unburned part of the charge. When the rate of increase in temperature due to this compression exceeds by some margin the rate at which a sufficient amount of the heat can be dissipated to the cylinder walls, the remaining portion ignites spontaneously and nearly simultaneously throughout. This theory apparently implies that a fuel should have a tendency to knock that is proportional to its spontaneous-ignition temperature.

The third theory explains the phenomena incident to the fuel knock as resulting from the impact of a high-velocity, high-pressure wave against the cylinder walls and head. It has previously been demonstrated mathematically that during the passage of a flame through a combustible mixture in a closed container, a higher pressure must exist immediately in front of the flame front than behind it.

If the auto-ignition gives a correct explanation of detonation, the only means of controlling detonation under a given set of conditions would be to raise the spontaneous-ignition temperature of the fuel. If the third or high-velocity, high-pressure wave theory is correct, detonation may be controlled by affecting the reaction velocity of combustion. The history of contact catalysis indicates that there should be negative combustion catalysts, very small percentages of which would exert a large effect on the reaction velocity of combustion. Although such a method of reasoning might well have served as the basis of search for a material to negatively catalyze combustion, the actual discovery of materials that exert just such an effect preceded the development of the high-velocity, high-pressure wave theory, it having been an outgrowth of many attempts to explain the remarkable behavior of these substances. In view of the very small amounts of some compounds that need be present in a combustible mixture in order to prevent detonation, it does not seem possible to account for their behavior on the basis of the auto-ignition theory of the knock. However, on the basis of a negative catalytic effect on the reaction velocity of combustion, the behavior of the materials discussed in this paper is in agreement with the high-velocity, high-pressure wave theory of detonation.

It has been found that detonation can be either suppressed or induced by the presence of very small amounts of certain materials in the combustible mixture. These substances may be dissolved or suspended in the fuel, or they may be admitted to the combustion chamber in some other way. The action of practically every type of compound that should affect detonation has been tried, and a large number have been found to possess the property of affecting combustion in such a way as either to suppress or induce detonation.

If the high-velocity, high-pressure wave theory of detonation is correct, the action of these materials is to affect the reaction velocity of combustion in such a way as either to accelerate or retard the tendency of the combustion to reach the velocity of detonation. Because of this effect, substances which, when present in small percentages, exert a powerful suppressing action on detonation have been termed "anti-knock materials" or "compressionizers."

*Extract of paper read by Thomas Midgley and T. A. Boyd, before the American Petroleum Institute, St. Louis, Mo., Dec. 6, 1922.

Design of Flanges for High Pressure and Superheat

The paper on "The Commercial Economy of High Pressure and Superheat,"[1] which George A. Orrok presented at the recent annual meeting of the A.S.M.E., was accompanied by an appendix (prepared by W. S. Morrison) on the effect of high steam temperatures on the strength of metals. In his discussion of this paper D. S. Jacobus made the following remarks upon the difficulties of designing flanges to withstand high temperatures:

The increase in steam pressures has proceeded so rapidly that there is no standard for flanged fittings for the higher pressures. A number are working actively on designs that eventually will come before the proper committees of the Society for adoption as standards. Flanges for steam fittings have not been standardized for pressures in excess of 250 lb. per sq.in. A statement is made in the report of the committee of this society on Standardization of Flanges and Pipe Fittings, published in the 1918 volume of the *Transactions*, that flanges constructed in accordance with a table it prepared for 800-lb. hydraulic pressure should be all right for 400-lb. steam pressure and steam temperatures not exceeding 250 deg. superheat. The arrangement for the hydraulic flanges is not, however, what it should be for high-pressure steam flanges on account of the great amount of overhang of the bolts.

The results of tests on the properties of metals at high temperatures given by Mr. Morrison show clearly that there need be no apprehension respecting the ability of the piping to withstand the pressure. The falling off in the elastic limit at high temperatures is, however, much greater than the falling off of the ultimate strength, and this affects the design of flanges, as with too great an overhang of the bolts the flanges may become distorted, owing to the initial strain and to the strains caused by the alternate expansion and contraction. Another feature that should be borne in mind is that if the bolts are placed too far from the pipe, so that they may be at a considerably lower temperature than the pipe, it is entirely possible to strain the bolts beyond their elastic limit through the difference in expansion of the flanges and the bolts. All features point to the advisability of making the bolt circle as small as it can be made and be consistent with good design.

Another feature that should be borne in mind in designing flanges is that the bolts may be set up so hard that something will have to give. It is necessary, therefore, to decide what should be the weakest element in case of overstrain. Offhand, it would seem that it would be best to make the bolts the weaker element, as in case of overstrain, they could be readily replaced, whereas should the bolts be made strong enough to dish and distort the flanges, the flanges would have to be replaced. Of course the bolts should be much stronger than required to hold the flanges together and to make a tight joint under ordinary conditions.

[1]The Oct. 31, 1922 issue of *Power* contained a long abstract of this paper, while a short abstract of the paper and the discussion was printed in the Dec. 12 issue.

News in the Field of Power

Columbia Project Again

Board Recommends Power Development of Flathead Lake — Two Lower Lakes for Irrigation

THE FLATHEAD Lake power project is now being actively considered by the Federal Power Commission. The development of the 275,000 hp. capable of being harnessed at that point has a bearing on the Columbia Basin project of the State of Washington. Washington officials are urging that no power rights be given unless the interests of irrigation are given priority.

The Rocky Mountain Power Co., a subsidiary of the Montana Power Co. and of the Anaconda Copper Mining Co., was one of the first concerns to apply for a preliminary permit following the passage of the water-power act. The Federal Power Commission's board of engineers found that Priest Lake and Pend d'Oreille Lake have all the storage capacity necessary for the Columbia Basin project, provided the natural flow from Flathead Lake is not interfered with during the critical months of the irrigation season. For that reason the board recommended that Flathead Lake be reserved for power users and the two lower lakes for irrigation storage.

The case is of unusual interest, not alone due to the large amount of power involved but to the principle as to just how far water for agricultural purposes may take precedence over that to be used for power purposes. The logical power development of Flathead Lake would affect adversely only a small portion of the irrigable territory. It is typical of numerous cases where the logical development is to use the upper storage for power purposes, providing for the restoring of the water lower down after it has served its power-making purpose.

Delay Building Dam in Ohio

Both the War Department and the Federal Power Commission are anxious to have a decision reached in the controversy over the power to be made available with the completion of dam No. 41 in the Ohio River at Louisville. The rival contenders for this power are the city of Louisville and the H. M. Byllesby Co. Representatives of each party are to present their arguments before the Secretary of War on Jan. 22.

Construction of the dam is being delayed, pending the outcome of the controversy. It is felt that the successful applicant should co-operate with the district engineer in the design of the dam, so that the 35 ft. of head to be created may be used to the best advantage.

Since the city of Louisville is not in a position to make the full utilization of the power, it is anticipated that the Federal Power Commission will decide the case in favor of the Louisville Hydro-Electric Co., a Byllesby subsidiary, and the actual applicant for the power project.

Conrad E. Spens Resigns

His Work Over, Fuel Distributer Returns to Private Life—Office May Be Closed Shortly

THE RESIGNATION of Conrad E. Spens as Federal Fuel Distributer went to President Harding on Dec. 27 and took effect Jan. 1. Accompanying the resignation was a brief report on the work of the emergency office, established Sept. 22 after the conclusion of the coal strikes.

It is considered probable that the fuel distribution office will be closed after the first week of the new year, although an organization will be held together to care for leftover details. Under the law creating the emergency fuel distribution, President Harding may terminate its activities at any time by withdrawing the proclamation declaring an emergency, under which it has functioned.

A large part of the work of the office has been in conjunction with the Interstate Commerce Commission in focusing coal transportation for special uses. Practically all of the orders in this connection have been either executed or suspended. A series of voluntary price agreements, fixing approximate levels for the sale of domestic coal, have been entered into by bituminous coal operators in nearly all of the large producing districts, and it is expected that these, in the main, will be adhered to after the closing of the distribution office.

Mr. Spens has returned to his former post as vice-president of the Chicago, Burlington & Quincy Railroad, with headquarters at Chicago.

New Plant Capacity Trebled

The capacity of the Oklahoma General Power Co.'s plant near Muskogee, originally planned for 10,000 hp., will be increased to 30,000 hp., and announcement has been made that the Oklahoma Gas and Electric Co. will construct another steam generating station of 20,000 hp. capacity near Harrah, about twenty miles from Oklahoma City.

Both of the plants will be erected under the direction of Byllesby Engineering and Management Corp. They will increase the Oklahoma utilities' total capacity to 84,100 hp., a gain of 146 per cent.

Are You Exporting Boilers?

Information on Foreign Boiler Laws Is Available—Power Station Data Also Being Collected

AMERICAN exporters of steam boilers who want information on the boiler laws of foreign countries may obtain this information from C. W. Obert, secretary of the A.S.M.E. Boiler Code Committee, 29 West 39th St., New York City, or from the Industrial Machinery Division, Bureau of Foreign and Domestic Commerce, Washington, D.C.

The Industrial Machinery Division was organized in the fall of 1921, and one of the first problems attacked by it was that of the exportation of American steam boilers. A reasonably complete selection of foreign boiler laws has been made and is available to the American manufacturer for use in connection with his daily problems.

For the last three or four years, the Boiler Code Committee has been cooperating actively with the Bureau of Foreign and Domestic Commerce, and it now maintains a duplicate file of all data at Washington concerning foreign boiler laws. Copies of the Committee's records will be loaned to any boiler manufacturer interested in making foreign shipments.

The collection of data on public-service power stations is another servive being performed by the Bureau of Foreign and Domestic Commerce, through its Electrical Equipment Division. Such data is taken from consular reports and from all possible commercial channels. The bulk of this matter has been obtained and is being card indexed. The plan is to have in the division a master reference file which will give all necessary commercial and technical information on any public-service light and power system in the world.

Statistics on exports of American electrical goods are published periodically by the Electrical Equipment Division. These are useful for analyzing American participation in the electrical trade.

Favor American Pumps in South Africa

Seventy-five per cent of the centrifugal pumps used in South Africa are of American manufacture, says Consul Charles J. Pisar in a report to the Department of Commerce. The duty on pumps is 3 per cent ad valorem, except for those imported from Great Britain or its colonies, which are exempt. This, however, offers no serious handicap to American pump manufacturers, and the increasing demand for windmills and pumps, the consul be-

lieves, offers them an excellent opportunity to enlarge their business in South Africa.

Most of the large pumps used in the mining industry are imported from England and Switzerland, and to a smaller extent from the United States. Fully ninety per cent of the pumps imported for farm use come from the United States. Windmill pumps are used more widely on farms than any other type.

Obituary

Frank J. Baker, vice-president of the Public Service Co. of Northern Illinois, died suddenly on Dec. 18. He was born in Cleveland, Ohio, on Sept. 11, 1864, and was educated at the University of Michigan, graduating in 1887. Later he studied at the Northwestern University Law School in Chicago, obtaining the degree of bachelor of laws in 1897. In 1887 he worked for a short time as a lineman on the pioneer electric railway at Richmond, Virginia, which was equipped and placed in operation by Frank J. Sprague.

Mr. Baker was a member of the American Institute of Electrical Engineers, National Electric Light Association and Western Society of Engineers. For many years he had been a member of the executive committee of the Illinois State Electric Association. He was a thirty-second degree Mason.

Personal Mention

Col. Arthur S. Dwight has received international recognition by being elected to honorary membership in the Chemical, Metallurgical & Mining Society of South Africa.

Charles F. Rand, chairman of the Engineering Foundation, has been elected to honorary membership in the Association of Members of American National Engineering Societies in Cuba.

Alfred B. Carhart has resigned as vice-president and sales manager of the Crosby Steam Gage & Valve Co. to become president and general manager of the Precision Instrument Co., Inc., Newark, N. J.

Frank H. Fox, formerly electrical engineer with Burns & McDonnell, Kansas City, Mo., has joined the organization of Arthur L. Mullergren, consulting engineer of Kansas City, in the capacity of principal assisting engineer. **E. M. Smith**, formerly structural engineer with the Houston (Texas) Light & Power Co. and the Sinclair Refining Co., has joined the Mullergren organization in a similar capacity.

Society Affairs

Metropolitan Section, A.S.M.E., will meet on Jan. 4 at the Engineering Societies Building to hear B. N. Broido's paper on "High Temperature of High Pressure Steam Lines," which was presented by title only at the 1922 annual meeting.

Metropolitan Section, A.S.M.E., will consider "Marine Diesel Engines" at its meeting on Jan. 10.

Utica Section, A.S.M.E., will hear, on Jan. 4, an illustrated address by Calvin W. Rice on "The Engineering Societies of South America."

Baltimore Section, A.S.M.E., will meet Jan. 10 at the Engineers' Club. George H. Gibson, of the H.S.B.W.-Cochrane Corp., will talk on "Influence of Feed Water Heating on Power-Plant Efficiency."

Cleveland Section, A.S.M.E., will participate on Jan. 9 in a joint meeting of the Council of Associated Technical Societies of Cleveland, in memorial to Samuel T. Wellman, past president of the A.S.M.E. James H. Stratton engineer in the Wellman-Seaver-Morgan Co., will speak.

Coming Conventions

Society of Automotive Engineers; 29 W. 39th St., New York City. Annual meeting at New York City, Jan. 9-12.

American Engineering Council; L. W. Wallace, secretary, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 11-12.

Compressed Gas Manufacturers' Association; John H. Hays, 120 W. 42d St., New York City. Annual meeting at New York City, Jan. 15.

Marine Engineers' Beneficial Association; George A. Grubb, secretary, Machinists' Bldg., 9th St. and Mount Vernon Place, Washington, D. C. Annual meeting at Washington, Jan. 15-20.

American Society of Civil Engineers, 29 W. 39th St., New York City. Annual meeting at New York City, Jan. 17-18.

Iowa Engineering Society; Lloyd A. Canfield, secretary, 406 Flynn Bldg., Des Moines. Annual meeting at Des Moines, Jan. 23-26.

American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City. Annual meeting: Jan. 23 at New York City, Jan. 24-26 at Washington, D. C.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Mid-winter convention at New York City, Feb. 14-16.

American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 19-21.

Business Notes

Roller-Smith Co., 233 Broadway, N. Y. City, has appointed the Electric Materials Co., as its agents in the State of Washington and parts of Oregon and Idaho. The Seattle office, in the Hinckley Building, is in charge of R. F. Robinson. The Electric Materials Company's main office is at 589 Howard St., San Francisco, Cal., and there is also a branch office in the Title Insurance Bldg., Los Angeles, California.

The Brazilian Hydro-Electric Co. has ordered two 25,000 kva. alternating current generators from the International General Electric Co., for installation in its Parahyba station. This station is located on the Parahyba River about 100 miles from Rio de Janeiro, and it will operate in connection with the existing generating and transmission systems of the Rio de Janeiro Tramway, Light and Power Co. Power will be transmitted at 132,000 volts. The ultimate capacity of the station will be 125,000 kilovolt-amperes.

Trade Catalogs

Under-Feed Stokers — Under-Feed Stoker Co. of America, Worcester, Mass. Booklet describing the Jones standard under-feed stoker, with emphasis on the simultaneous automatic regulation of fuel and air.

Condenser Tubes — Chase Metal Works, Waterbury, Conn. A booklet describing the manufacture of condenser tubes, from the raw materials—Admiralty or Muntz metal—to the finished product. A series of excellent halftones shows each manufacturing and testing process, while the effects of drawing and annealing on grain size in the metal are illustrated by microphotographs.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Dec. 11, 1922	Dec. 18, 1922
Pool 1,	New York	$5.00–5.50	$5.50–6.00
Smokeless,	Columbus	5.75–6.25	5.75–6.25
Clearfield,	Boston	3.25–4.00	3.50–4.85
Somerset,	Boston	3.50–4.25	3.75–4.50
Kanawha,	Columbus	3.00–3.50	2.90–3.10
Hocking,	Columbus	2.50–2.75	2.50–2.75
Pittsburgh No. 8	Cleveland	3.00–3.25	3.15–3.25
Franklin, Ill.,	Chicago	4.00–4.25	4.00–4.25
Central, Ill.,	Chicago	3.00–3.25	3.00–3.25
Ind. 4th Vein,	Chicago	3.75–4.00	3.75–4.00
West Ky.,	Louisville	2.00–2.50	2.00–2.50
Big Seam,	Birmingham	2.25–2.50	2.25–2.50
S. E. Ky.,	Louisville	3.00–3.75	3.00–3.75

FUEL OIL

New York—Dec. 27, Port Arthur light oil, 22@25 deg. Baumé, 4¼c. per gal.; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago — Dec. 16, for 24@26 deg. Baumé, 90c. per bbl.; 32@36 deg., 2¼@3c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

Philadelphia — Dec. 23, 26@28 deg. Baumé, Oklahoma, 90@95c. per bbl.; 30@34 deg., Oklahoma (group 3), 2⅝@2¾c. per gal.; 16@20 deg. Seaboard, $1.30@$1.40 per bbl.

St. Louis—Dec. 19, f.o.b. Oklahoma 24@26 deg., 95c. per bbl.; 26@28 deg., $1 per bbl.; 28@30 deg., $1@$1.05 per bbl.; Gas oil 32@36 deg., 2¾c. per gal.; 36@40 deg., distillate, 3½c. per gal.

Pittsburgh — Dec. 20, f.o.b., refinery, Penn., 36@40 deg., 5½@5¾c. per gal.; Kentucky, 26@30 deg., 4c.; Diesel, 3¼c.; Gas oil, 32@.6 deg., 2½@2¾c.; 36@38 deg., 2½@3c.; 38@40 deg., 2¾@3¼c. per gal.; Western, 24@30 deg., 90c.@$1.05 per bbl.

Dallas — Dec. 23, 26@30 deg., $1.25 per bbl.

New Plant Construction

PROPOSED WORK

Calif., Bakersfield—T. J. Coleman, Mgr. St. Francis Hotel, San Francisco, and others, plan the construction of a 3 story hotel and stores, on 19th and I Sts. Estimated cost $500,000. Architect not selected.

Calif., Delhi—The Delhi Land Settlement Colony, received bids for pumping plants from the United Iron Works, 2308 Webster St., Oakland, $7,060; Byron Jackson Iron Works, 55 New Montgomery St., San Francisco, $7,300; King Knight Co., 525 Market St., San Francisco, $10,541, above contracts include installation; Manistee Iron Works, Rialto Bldg., San Francisco, $7,500 not including installation.

Calif., Dixon—The East Dixon Irrigation Dist., have had plans prepared for irrigation and drainage of about 60,000 acres, involving 5 pumping plants, about 30 in. and 40 in. in size with electric motors, 17 mi. of main canal and about 40 mi. laterals. F. C. Herrmann, Merchants Exchange Bldg., San Francisco, Engr.

Calif., Fullerton—The Placienda Orange Growers' Assn. plans the construction of a refrigerating and pre-cooling plant. Estimated cost $150,000.

Calif., Hollywood (Los Angeles P. O.)—R. H. Orr, Archt., Van Nuys Bldg., Los Angeles, is receiving bids for a 5 story, 40 x 199 ft. hospital on Vermont Ave., for the Hollywood Hospital Assn., here. Estimated cost $300,000. Equipment detail not reported.

Calif., Lodi—The city trustees will receive bids until Jan. 18 for furnishing machinery for sewage disposal plant, including two 1,000 gal. (enclosed) and one 800 gal. per min. open runner-type centrifugal pumps, three 5 hp. 40 deg. 440 voltage, three 30 and one 100 hp. 40 deg. 220 voltage electric motors, one 1,400 cu.ft. air compressor with separator attached, three 450 cu.ft. air compressors, two 100 g.p.m. Kewanee pressure water system, 2 water meters, 2 air-flow meters, 1 fine screen, 2 Dorr clarifiers and 1,800 filtrous plates for diffusing air through sewage. Alternate bids will be received. L. F. Barzellotti, City Engr. C. F. Smith, 7 Nottingham Ave., Berkeley, Consult. Engr.

Calif., Los Angeles—Lange & Bergstrom, Washington Bldg., are having plans prepared for the construction of an 8 story apartment building on Parkview St. Estimated cost $650,000. Walker & Eisen, Pacific Finance Bldg., Archts. Equipment detail not reported.

Calif., Modesto—J. S. West, 709 9th St., plans the construction of an ice plant. Estimated cost $30,000.

Calif., Petaluma — The Petaluma Ice & Cold Storage Co., Postal Telegraph Bldg., San Francisco, is having plans prepared for the construction of alterations and additions and the installation of equipment for cold storage plant, here. Estimated cost $100,000. Private plans.

Calif., San Francisco—The Bd. of Pub. Wks., will receive bids until Jan. 10, for furnishing and delivering electric transmission line conductors for 3 phase, 154,000 volt circuits, each about 96 mi. long and for material to extend 1 circuit an additional 41 mi. F.O.B. cars San Francisco. Estimated cost about $500,000.

Calif., Stockton—The Terminal Cold Storage & Warehouse Co., c/o N. E. MacLean, Archt., California St., San Francisco, is having plans prepared for a pre-cooling plant at Main Channel and Mormon slough. Estimated cost $260,000.

Ill., Aviston—The Aviston Milling Co., is in the market for 15 kw. d.c. dynamos, 115 volts also 20 kva. to 50 kva. a.c. generator, 3 phase 60 cycle, 220-440 volt, 25 to 25 hp. a.c. motor.

Ill., Chicago—Anderson Electric Works, Inc., 212 West Austin Ave., is in the market for several alternating-current motors, all sizes.

Ill., Chicago—The Lincoln Square Hotel Co., c/o Olsen & Urbain, Archts., 155 North Clark St., is having plans prepared for a 4 story, 130 x 175 ft. hotel, including steam heating system at 525 Arlington Pl. Estimated cost $500,000.

Ill., Chicago—A. Lindstrom, c/o C. W. Westerlind, 179 West Washington St., plans the construction of a 3 story apartment building including steam heating system, at 4520 Drexel Blvd. Estimated cost $500,000.

Ill., Chicago—J. Rosenberg, c/o Ressman & Hirschfeld, Archts., 139 North Clark St., is having plans prepared for 3 apartment buildings, each 3 story, 125 x 169 ft., including steam heating system, on 55th and Everett Sts. Estimated cost $1,500,000.

Ind., Terre Haute—The Bd. Educ. have had revised plans prepared for the construction of a 2 story, 220 x 400 ft. high school on 25th St. Estimated cost $700,000. Johnson, Miller & Miller, 30 North 5th St., Archts. Warren & Lewis, Realty Bldg., Louisville, Ky., Engrs.

Ill., White Hall—The Hillview Drainage & Levee Dist., will receive bids until Jan. 8, 1923, for furnishing drainage pumping station equipment, consisting of one 15 in. vertical submerged centrifugal pump, one 30 in. horizontal centrifugal pump, one 150 hp. motor, one 50 hp. vertical motor, 2 switchboards, oil switches, starting apparatus, etc. Caldwell Engrs. Co., Jacksonville, Engrs.

Ind., Evansville—The Evansville Packing Co., Morgan Ave., is receiving bids for the construction of a 3 story, 31 x 42 ft. packing and refrigeration plant. Estimated cost $45,000. H. E. Boyle & Co., Furniture Bldg., Archts. Equipment detail not reported.

Ind., Indianapolis—The S. S. Kresge Co., Kresge Bldg., Detroit, Mich., plans the construction of a 14 story, 76 x 198 ft. office and store building at 7 East Washington St., here. Estimated cost $1,500,000. G. H. Rubens, Saks Bldg., Archt. Equipment detail not reported.

Ia., Clarinda—Swift & Co., 76 West Monroe St., Chicago, Ill., H. Gilmore, Mgr., Clarinda, is having plans prepared for a 2 story, 76 x 144 ft. cold storage plant here. Estimated cost $125,000. Equipment detail not reported.

Ky., Paducah — The Paducah Ice Co., plans the construction of a 2 story 75 x 220 ft. ice manufacturing plant on South 3rd St. Estimated cost $70,000. Pilsbury-Becker Engr. Co., 119 South 11th St., St. Louis, Mo., Archts. Noted Dec. 7.

Md., Baltimore—The Knights of Pythias, J. M. Hendricks, Grand Secy., 129 North Gay St., is having plans prepared for the construction of a 4 story lodge building on Charleston and Preston Sts. Estimated cost $600,000. C. N. and N. Friz, Lexington Bldg., Archts. Equipment detail not reported.

Mich., Albion—Albion College is having preliminary plans prepared for the construction of a 1 and 2 story gymnasium and central heating plant. Estimated cost $250,000. H. K. Ferguson Co., 6525 Euclid Ave., Cleveland, Archts.

Mich., Detroit—The First State Bank and Security Trust Co., Griswold St., has purchased site and plans the construction of a 4 story, 74 x 130 ft. bank and office building, including steam heating equipment, on Griswold and Lafayette Sts. Estimated cost $500,000. Architect not selected.

Mich., Jackson—The city plans the construction of a new pumping station and the installation of equipment including two 300 hp. boilers, at City Farm. Estimated cost $150,000. Engineer not selected.

Mich., Lansing—The Lansing Hotel Corp. is having plans prepared for the construction of an 11 story, 110 x 132 ft. hotel, including refrigeration system, on Michigan Ave. Estimated cost $1,000,000. Warren S. Holmes Co., Tussing Bldg., Archts.

Miss., Jackson—The Lamar Life Ins. Co. plans the construction of a 15 story office building on North Congress St. Estimated cost $750,000. Architect not selected.

N. J., Newark—Salaam Temple, A. A. O. N. M. S., 1020 Broad St., will receive new bids for the construction of a temple on Broad St. Estimated cost $1,000,000. F. Grad, 245 Springfield Ave., Archt. Former bids rejected.

N. Y., Brooklyn—The Bd. Educ., 500 Park Ave., New York, is having plans prepared for the construction of a P. S. 203, including steam heating system on Ave. M and East 51st St., here. Estimated cost $600,000. C. B. J. Snyder, Concord St. and Flatbush Ave. Ext., Archt. and Engr.

N. Y., Glenmorris (Jamaica P. O.)—The Bd. Educ., 500 Park Ave., New York, is having plans prepared for the construction of P. S. 121, including steam heating system on Shuwanee Ave., here. Estimated cost $500,000. C. B. J. Snyder, Concord St. and Flatbush Ave. Ext., Bklyn., Archt. and Engr.

N. Y., Westfield—The village plans changing its present power plant to use Niagara Falls power. Estimated cost, including new machinery and equipment $35,000.

N. C., Davidson—The city plans the construction of a new electrically operated pumping plant in connection with new waterworks system. Estimated cost $60,000. Mees & Mees, Kinney Bldg., Charlotte, N. C., Engrs.

N. C., Raleigh—S. Lloyd Preacher & Co., are preparing plans for the construction of an 8 story hotel on West Martin St. Estimated cost $250,000. Owner's name withheld.

N. D., LaMoure — The Midwest Power Co., L. Wilson, Mgr., is in the market for complete electric power plant machinery and equipment.

Ohio, Dayton—The Miami Ice & Fuel Co., P. B. Hunt, Pres., Ludlow Bldg., plans the construction of an ice plant. Estimated cost $250,000. A. C. Bishop & Co., Guardian Bldg., Cleveland, Archts.

Ohio, Greenville—The School Bd. is having plans prepared for the construction of a 3 story, 150 x 175 ft. high school, including steam heating system. Estimated cost $500,000. W. B. Ittner, 911 Locust St., St. Louis, Mo., Archt.

Okla., Clinton—The city plans extensions to waterworks and electric lighting system. Estimated cost $45,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Engrs.

Okla., Nowata—The city plans election Jan. 23, 1923, to vote $111,000 bonds for the construction of a 2,000,000 gal. reservoir, new pumps, mains and power plant. Engineer not announced.

Okla., Tulsa—The Central Nat. Bank, 2nd and Boston Sts., is having plans prepared for the construction of a 15 story, 50 x 140 ft. bank and office building. Estimated cost $1,000,000. N. H. Mahler Co., 231 Lynch Bldg., Archts. Equipment detail not reported.

Okla., Weatherford—The city plans the construction of power plant, and extensions to waterworks and electric light system. Estimated cost $114,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Engrs.

Okla., Wetumka—V. V. Long & Co., Engrs., 1300 Colcord St. Oklahoma City, submitted report for the construction of a water purification plant, mains and pumping equipment for the city. Estimated cost $83,000. Noted Nov. 21.

Okla., Wynne Wood—The City plans the construction of an electric light and power plant and extensions to waterworks. Estimated cost $55,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Engrs.

Ore., Astoria — The Hammond Lumber Co., A. B. Hammond, Pres., will rebuild plant destroyed by fire Nov. 11, plans include saw mill, planing mill, sash and door and box factory; also will purchase and install complete new machinery, boilers, engines, etc. Estimated cost $700,000. Private plans.

Pa., Allentown—The city, M. W. Gross, Mayor, 301 Central Fire & Police Station, is in the market for one 50 kw. generator set. Estimated cost $3,000.

Pa., Blossburg—Gannett, Seeley & Fleming, Inc., L. Weiss, Gen. Supt., Wellsboro, has taken over the Blossburg and Mansfield companies and plans the construction of an 80 x 90 ft. steam power plant, here, will extend lines over 40 mile area, reaching 17 counties. Estimated cost $150,000.

Pa., Union City—The Shreve Chair Co., is in the market for several new electric motors, also dust conveyor and sanding machinery.

S. C., Great Falls—The Republic Cotton Mills will receive bids until Jan. 15, for the construction of a 1 story, 400 x 4000 ft. cotton mill. Estimated cost $500,000. J. E. Sirrine, South Main St., Archt. Equipment detail not reported.

Tenn., Memphis—The Memphis Artesian Water Dept., Bd. of Comrs., will receive bids until Jan. 19, 1923, for furnishing and installing auxiliary equipment and boiler settings and for furnishing and delivering air flow meters in the new Parkway Pumping Station, the work to be divided into contracts as follows: Contract 11, auxiliary equipment; Contract 12, boiler settings; Contract 13, air flow meters. Fuller & McClintock, 879 North Parkway, Engrs.

Tex., Dallas—H. S. Green, Archt., Alamo Bank Bldg., San Antonio, will soon receive bids for the construction of a 14 story, 75 x 200 ft. hotel, on Commerce and Poydras Sts. for C. L. Sanger, 2429 South Blvd., Dallas, and associates. Estimated cost $400,000. Equipment detail not reported.

Tex., Ft. Worth—The Arctic Ice Co. have had plans prepared for the construction of a 2 story ice plant on Jassamine and Clay Sts. Estimated cost $60,000. Engineer not announced.

Tex., Perryton—The council plans $35,000 bond issue for the construction of a light and power plant. Owner is in the market for equipment.

Wash., Usk — R. M. Sandersen, Engr., South 321 Lincoln St., Spokane, is preparing plans for the construction of canals, diversion dam, dike, pumping plant, drainage system, etc., here, for W. F. Cochrane. Estimated cost $35,000. One 200 hp. and one 250 hp. pumps, 10 to 20 ft. lift, will be installed.

Wash., Walla Walla—Whitman College will receive bids in the spring for the construction of a central heating plant on the campus. Estimated cost $80,000. Equipment detail not reported.

Wis., Iron River—The Iron River Water & Light Co., L. H. Callahan, Mgr., plans to rebuild power plant, pump house and 2 dams, recently destroyed by flood. Estimated cost $150,000. Architect not selected. Power and pumping machinery will be required.

Wis., Jefferson — The County Bd., c/o County Clk., is in the market for refrigerating machinery for country farm.

Wis., Jefferson — W. Voight is in the market for power refrigeration machinery, several ton capacity.

Wis., Madison—Piper Bros. Co., 31 North Pinckney St. is having plans prepared for the construction of a 10 story, 101 x 164 ft. hotel, including steam heating plant, on Mifflin St. Estimated cost $850,000. Balch & Lippert, Gay Bldg., Archts.

Wis., Stevens Point — The Consolidated Water Power & Paper Co., G. W. Mead, Secy., Wisconsin Rapids, is having plans prepared for the construction of a 2 story paper mill, also a hydroelectric generating plant, here. Estimated cost $300,000. L. A. De Buere, Wisconsin Rapids, Engr.

Wis., Stratford—The Stratford Light & Power Co., plans the construction of a hydro electric generating plant with steam auxiliary and distribution system, including power equipment, etc. Estimated cost $65,000. Architect not selected.

Wis., Verona—Dane County Bd., M. Sommers, Chn., Court House, Madison, plans the construction of a 4 story, 100 x 140 ft. insane asylum, including a cold storage plant, here. Estimated cost $150,000. Architect not selected.

Wis., Waunakee—The Waunakee Canning Co., A. P. Kenney, Waunaka State Bank, plans the construction of a 2 story, 60 x 95 ft. canning factory. Estimated cost $100,000. Architect not selected. Power and canning machinery will be required.

Wis., Waupaca—The Lindsay Light & Poer Co. is having plans prepared for the construction of a hydroelectric generating and power plant, including machinery. Estimated cost $50,000. Private plans.

N. B., St. John—The Civic Hydro Comn., H. Phillips, Secy., has been authorized by the common council, to purchase 3 transformers. Estimated cost $25,000. (Noted Dec. 26.)

N. F., Pushthrough—H. J. Crowe, C. P. R. Bldg., Toronto, Ont., has had surveys made for water power development on Bay D'Est River and Bay D'Espoir on the south coast, to develop about 100,000 hp., 500 ft. head. Estimated cost $8,000,000 to $10,000,000. Hugh L. Cooper & Co., 101 Park Ave., New York and Kerry & Chase Ltd., 550 Confederation Life Bldg., Toronto, Ont., Engrs.

Ont., Branford—F. Adams, City Engr., is preparing plans for a waterworks pumping station for the city. Estimated cost $30,000. Prices wanted on equipment. Noted Feb. 7.

Ont., Campbellville—The council c/o R. C. Menzies plans to vote on bylaw Jan. 10, for the installation of electric lighting and power distribution system. Estimated cost $35,000. Prices wanted on all equipment.

Ont., Galt—The city has appointed James, Proctor & Redfern, Engrs., 36 Toronto St., Toronto, to prepare plans and estimates and report on waterworks system, it is probable new mains will be laid and additional pumps installed. Estimated cost $50,000.

Ont., Kincardine—The council plans to install gasoline waterworks pumping equipment, including auxiliary pump. Prices and information wanted on same. J. H. Scougall, Town Hall, Engr.

Ont., Lansing—The Twp. of North York H. D. Goode, Clk., is having estimates prepared for waterworks system, including pumps, pump house, reservoir or tank, c.i. mains, hydrants and valves, here. Estimated cost $125,000. James Proctor & Redfern, Ltd., 36 Toronto St., Toronto, Engrs.

Every one of these items is reported by our authorized correspondents who are instructed to verify every item sent in. This free weekly service is published in the interests of the buyer and the seller, to bring them together and get machinery moving.
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BUSINESS NEWS DEPARTMENT
Tenth Ave. at 36th St., New York

Ont., Tamworth—A. B. Caxscallen & Co., is in the market for 1 d.c. 125 volt generator, belt driven, 1 switchboard and equipment for same, waterwheel, governors, "Atrician" grinder, shafts, etc.

Ont., Thorold—The Thorold Post Printing Co., D. Fendell, Mgr., plans to install motor driven equipment for printing large show bills and similar work. Estimated cost $10,000. Prices wanted on motors and equipment.

Ont., Wiarton—Gilpin Bros. are in the market for a high or low speed 100 to 125 hp. engine.

Que., Sherbrooke—The Dominion Textile Co., Victoria Sq., Montreal, is in the market for boiler equipment and other machinery for plant here.

CONTRACTS AWARDED

Calif., Arrowhead — Swasey & McAfee, Archts., Hibernian Bldg., Los Angeles, awarded the contract for the construction of a 3 story hotel and store building, to the Atwood Constr. Co., San Bernardino, $240,000. Owner's name withheld. Equipment detail not reported.

Calif., Sacramento—The Consumers' Ice & Cold Storage Co., 8th and D Sts., will build by day labor, an addition to ice plant on Hickman Tract near Freeport Rd. Estimated cost $41,000. Equipment detail not reported.

Calif., San Francisco — The city and county of San Francisco awarded the contract for furnishing and installing an electric traveling crane at the Mocassin Creek power plant, Hetch Hetchy project, to Pawling & Harneschfeger, 32 Beale St., $30,475. Noted Nov. 21.

Ind., Indianapolis — The American Can Co., 120 Bway., New York, awarded the contract for the construction of a 4 story, 34 x 230 ft. factory here, to the Ferro Concrete Constr. Co., 3rd and Elm Sts., Cincinnati, Ohio. Estimated cost $300,000. Equipment detail not reported.

Ind., Indianapolis—The Polar Ice & Fuel Co., 2000 Northwestern Ave., awarded the contract for the construction of a 47 x 81 ft. ice plant addition, to W. Jungclaus Co., 825 Massachusetts Ave. Estimated cost $27,000. Equipment detail not reported.

Ind., Madison—The Pearl Packing Co. will build by day labor a 1 story, 56 x 120 ft. packing plant, including steam heating, refrigeration and cork insulation. Estimated cost $26,000. M. P. Burt & Co., Falls Bldg., Memphis, Tenn., Engrs.

Ia., Knoxville—The U. S. Veterans' Bureau, W. H. Hart, Quartermaster Gen., 2306 Munitions Bldg., Wash., D. C., awarded the contract for the construction of a U. S. Veterans' hospital, including heating, plumbing, etc., main building, and 8 subsidiary buildings consisting of laundry, nurses' quarters, officers' quarters, mess and kitchen building, tuberculosis cottage, etc., to the Warner Constr. Co., 730 Waveland Ave., Chicago, Ill., $889,974. Noted Dec. 26.

Mich., Lansing—The St. Lawrence Hospital Assn., 101 Wellon St., awarded the contract for the construction of a 4 story, 131 x 183 ft., hospital to the Renegar Constr. Co., 336½ East Michigan Ave., about $400,000; heating and power to Wheeler & Blaney, Eleanor St., Kalamazoo.

Mo., Valley Park—The city, R. P. Sargeant, Mayor, awarded the contract for waterworks distributioon system, to Merkle Machine & Constr. Co., Walnut St., Kansas City. $31,103. Two 350 g.p.m. triplex, motor driven pumps and a 100,000 gal. tank and tower will be purchased the latter part of Jan. Noted Nov. 14.

N. J., Wildwood — The O. H. Ice Co. awarded the contract for the construction of an 80 x 120 ft. ice plant to M. B. Reeves. Estimated cost $25,000. Equipment detail not reported.

N. Y., Brooklyn—The C & K Constr. Co., Shampan & Shampan Archts., 50 Court St., will build by day labor a 6 story, 135 x 210 ft. apartment building on Ocean Ave. Estimated cost $750,000. Equipment detail not reported.

N. Y., New York—I. Feldman, c/o C. B. Meyers, Archt. and Engr., 31 Union Sq., will build by day labor, a 15 story, 40 x 220 ft. hotel, on 100th St. and Bway. Equipment detail not reported.

N. Y., New York—The Gilbur Corp., Inc., A. Quinn, Pres., 205 West 37th St., will build a 17 story, 98 x 244 ft. loft building on 7th Ave. and 37th St., by separate contracts. Estimated cost $1,500,000. Buchman & Kahn, 56 West 45th St., Archts. and Engrs. Steel work has been awarded to Levering & Garrigues Co., 552 West 23rd St. Equipment detail not reported.

Tenn., Union City—The Brown Shoe Co., 1700 Washington Ave., St. Louis, Mo., awarded the contract for the construction of a 3 story, 45 x 250 ft. and 60 x 80 ft. factory, to T. J. Nahahan, Boatmen's Bank Bldg., St. Louis, Mo. Estimated cost $200,000. Owner is in the market for complete power plant equipment, heating and sprinkling systems and machinery.

W. Va., Wheeling—The city awarded the contract for machinery for electrically driven pumping plant for new waterworks and filtration system to the Worthington Pump & Machinery Corp., 115 Bway, New York, $76,345. Noted Dec. 19.

W. Va., Williamson—The Williamson Ice & Storage Co., awarded the contract for a 5 story, 40 x 60 ft. ice plant, to the Good Constr. Co. Estimated cost $60,000. Equipment detail not reported.

Wis., Racine—The New Racine Hotel Co., C. Fowler, Secy., Badger Bldg., awarded the contract for the construction of an 8 story, 104 x 240 ft. hotel and office building on Main and 6th Sts., to Starrett Bros., 8 South Dearborn St., Chicago, Ill. Estimated cost $2,400,000. D. H. Burnham & Co. 209 South La Salle St. Chicago, Ill., Archts. and Engrs. Equipment detail not reported. Noted Dec. 26.

Ont., London—The Pub. Utilities Comn., awarded the contract for 1500 kw. transformers, to the General Electric Co., $35,000.

Que., Montreal—The city awarded the contract for the construction of a 46 x 58 x 103 ft. distribution control building for the new pumping station on Atwater Ave. to the E. G. M. Cape & Co., Cathcart St., $167,000. Noted Dec. 12.